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中国锄足蟾科的细胞分类学研究

Ⅳ． 4种齿蟾的核型及其C⁻带分析

（图版Ⅰ）

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材料与方法

1． 峨眉齿蟾：1986.4及1987.3，采自四川省洪雅县柳江区，距模式标本产地约60公里。

2． 秉志齿蟾：1985.5及1986.10，采自四川省昭觉县。

3． 宝兴齿蟾：分别于1984.10月采自四川省茂汶县及1986.4采自洪雅县。

4． 疣痣齿蟾：1985.5及1986.10采自四川省昭觉县。

染色体组型标本采用离体骨髓离心（见赵尔宓1983）及蒸汽固定法（吴政安，1982）制备；C⁻带显带技术按Sumner（1972）法制备。观察的个体数及细胞数详见表1.

结果和种间比较

1． **染色体组型：**

4种齿蟾染色体的二倍体数均是26（图版Ⅰ：A-H），13对同源染色体由5对大的（Nos.1-5）、1对中型的（No.6）和7对小染色体（Nos.7-13）组成，在No.5与No.6之间，No.6与No.7之间在长度上存在比较明显的分界线。全部种的No.6的长臂中段上显示了一恒定的次缢痕。鉴于它们具有一个基本相似的核型式，参考本亚科中已知有关属的资料，也将它们分成3组，各染色体相对长度与臂比值等，按分组排列于表2，种间差别可查看表2进行比较，文中不一一分别描述。

Table I The summary of materials examined in this study

Species	Individuals and Sexes		Numbers of metaphase	
			Giemsa Stained	C-banded
Oreolalax omeimontis	♂	6	50	20
	♀	2		30
O. pingii	♂	5	30	
	♀	2	37	9
	♂	8	105	40
O. popei	♀			
O. rugosa	♂	10	246	11
	♀	1	36	3

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此外，疣痣齿蟾的组型有个体变异。一雄性中所观察的全部中期分裂相中，分别具有2n＝27、2n＝28、2n＝29等不同二倍体数（见图版Ⅰ，图2 I-K），分别多于正常核型1条、2条或3条，但超数的都属于端部着丝粒染色体(t)，其形态相似于爬行类中普遍具有的微小染色体(microchromosomes)，而它前面的13对同源染色体与那些2n＝26正常型的相对长度和分型上则均无差别。该染色体在核型中出现没有恒定的数目，没有确切的依据来分析这种变异的性质。

比较了峨眉齿蟾、秉志齿蟾、疣痣齿蟾等3种雌、雄两性间的常规染色组型，未发现两性间的染色体有性异型现象；宝兴齿蟾在茂汶县和洪雅县两地区均只采获雄性标本，两地区的核型也没有可见的差别。

2. C带带型：（图版I,B、D、F、H）

2.1 着丝粒区：4种的着丝粒区均呈阳性深染C⁻带。宝兴齿蟾着丝粒C⁻带较丰富，与其近区的阳性区联接呈“X”状斑，其他几种则C⁻带区较小与前者显著区别。

2.2 端粒区：宝兴齿蟾各条染色体的长、短臂末端均出现较深的C带；秉志齿蟾仅NOs.1-5对染色体长臂末端C⁻带较微弱；疣痣齿蟾则缺如。

2.3 臂间区：各种的No.6染色体长臂上次缢痕区与着丝粒之间的段位有深染C⁻带大斑，但形状各异。疣痣齿蟾除此大斑外，在缢痕间隙区另一端缘也有小的插入C带（图版Ⅰ，H）；宝兴齿蟾该对染色体C带出现异型现象，同源对中之一C⁻带区显著增大，约占据了该臂2/3以上面积，所观察的细胞总是存在此一异型特征。

讨　论

1. 关于染色体组型　观察结果和比较可见，4种齿蟾具有相似核型模式，染色体的数目无变化，组型的结构简单，仅包含了m、sm两个类型的染色体，除疣痣齿蟾*Oreolalax rugosa*有较多的sm染色体而易于识别外，另3个种群中不论在大型与小型组染色体在种群相互之间并无太大差异，显示为核型分化不明显。特别是4种齿蟾中不论同域或异域分布的种，一致地在NO.6的相同臂位上均有一恒定而显著次缢痕，在经历了长期演化的过程以后，并未导至其位置有可见的改变，至今仍然保持着这一具有标志性的共有特征，反映了齿蟾属核型的保守趋向。所见这些特征，与髭蟾属*Vibrissaphora*极相似（赵尔宓等，1983）几乎不可区分，唯一可比较区别是齿蟾属内的大型组染色体具有较高臂比值或有较多的sm染色体。齿蟾属与髭蟾属是互为亲近的属，外形上是十分清楚的，但两者细胞学的形态特征则显示了更为接近的关系。

2. 关于C带带型　无尾类一些较高级类群，如蟾蜍(Bufonidae)、雨蛙（Hylidae）、蛙科(Ranidae)、姬蛙（Microhylidae）和树蛙（Rhacophoridae）等科中的C显带资料表明，存在较多的异染色质区，所有的着丝粒区均有C⁻带，大多数种的长、短臂末端有C带，一些或个别染色体还有臂间插入带（Schmid，1978a，b；1980）。锄足蟾科（Pelobatidae）的C带带型研究较少，从4种齿蟾C显带结果看，除宝兴齿蟾略有列外，其余种的着丝粒虽然也均显C⁻带，但C带斑块显著较小，长、短臂端均不具有C⁻带，臂间区除在NO.6上伴随着次痕缢附近出现C带外，其他染色体均无插入带。这与上述各科相比有明显的区别；从另一亚科即角蟾亚科（Megophryinae）中已知的*Megophrys nasuta*，*Pelobates fuscus*（见Schmid，1980a）和无耳蟾*Atympanophrys shapingensis*（吴贯夫，1987.8）等3属3种C带核型来看，也仍然揭示了类似的区别特征。由此可见，古老的锄足蟾科中较少而又不太发达的C⁻带可能表明它和一些较高级的类群之间存在的普遍性差别。

结构异染色质普遍被认为与核型的进化

有密切关系，染色体由倒位、断裂等方式引起结构上重组的变化，常发生在这些区域，某些臂末端C带和臂间插入带，是变化后失活的着丝粒所留下的残迹(Schmid, 1978a)，其数量多少在一定程度上可籍以估计它们变化的频次；另一种是少数种类中个别染色体的短臂上或者是在长臂上大面积或者整臂异染色质化的情况，如像在 *Pyxicephalus adspersus* (=*Rana adspersus*) 的ZZ/ZW性染色体的w染色体长臂上（见Schmid, 1980b）和南美的 *Litoria infrafrenata* No.4 长臂上(King, 1980)所见那样，该臂大面积C带出现实事上表明异染色质量的增加，这种现象由倒位方式来产生似乎是不可能的。根据King (1980) 的见解，染色体重组存在主要靠异染色质的量和位置来进行内部调整的过程，它涉及了常染色质的转化到异染色质的增加，这一过程则表现为进化中的演化状态。本文中的宝兴齿蟾如图F,L所示，它的No.6一对同源染色体之间的形态大小和着丝粒位置，并无可见的变化，但C显带出现异型，其中一条长臂上总是占有明显优势的异染色质区，虽然目前还不明了这种现象是否诸如与性染色体分化等性质有无关系，但不

Table 2 The Relative Lengths and Arm Ratio of metaphase chromosomes of four *Oreolalax* species

		O. omeimontis ♂			*O. pingii* ♂		
		R. L.	A. R.	Type	R. L.	A. R.	Type
I	1	161.67±13.2	1.2±0.05	m	167.21±11.4	1.29±0.10	m
	2	129.96±7.4	1.69±0.16	m. sm	139.13±7.5	1.60±0.13	m
	3	112.53±5.4	1.77±0.14	sm	123.83±6.5	1.93±0.27	sm
	4	105.13±5.4	1.73±0.21	sm	113.78±3.7	1.78±0.16	sm
	5	98.35±2.6	1.54±0.14	m	98.83±6.4	1.60±0.17	m. sm
II	6	71.71±4.2	1.34±0.21	m	69.82±4.4	1.23±0.11	m
III	7	55.19±3.0	1.45±0.20	m	49.78±3.2	1.50±0.18	m
	8	51.38±2.9	1.61±0.20	m. sm	47.74±3.7	1.80±0.19	sm
	9	49.61±5.0	1.59±0.21	m. sm	46.07±3.1	1.52±0.13	m
	10	45.86±2.6	1.14±0.13	m	41.26±3.7	1.25±0.14	m
	11	42.12±3.4	1.11±0.13	m	36.74±2.1	1.28±0.19	m
	12	39.43±4.0	1.08±0.11	m	33.4 ±4.6	2.38±0.24	sm
	13	36.94±4.0	1.06±0.07	m	32.77±4.0	1.26±0.26	m

		O. popei ♂			*O. rugosa* ♂		
		R. L.	A. R.	Type	R. L.	A. R.	Type
I	1	158.72±10.1	1.17±0.12	m	158.24±10.3	1.34±0.13	m
	2	132.41±8.6	1.71±0.19	sm	135.7 ±7.2	1.58±0.25	m. sm
	3	119.67±6.3	1.91±0.24	sm	115.39±3.4	1.79±0.16	sm
	4	110.47±5.1	1.66±0.19	m. sm	111.08±5.8	1.69±0.13	sm
	5	99.21±4.0	1.38±0.09	m	94.11±4.4	1.86±0.30	sm
II	6	79.66±7.2	1.25±0.15	m	79.71±7.1	1.77±0.22	sm
III	7	53.00±3.1	1.41±0.16	m	53.99±3.2	1.61±0.16	m. sm
	8	51.49±3.9	1.42±0.24	m	51.09±3.9	1.61±0.17	m. sm
	9	47.31±3.4	1.38±0.25	m	47.71±1.7	1.57±0.19	m. sm
	10	43.39±5.2	1.33±0.21	m	42.43±2.7	1.24±0.21	m
	11	39.68±3.3	1.31±0.19	m	40.39±2.3	1.27±0.19	m
	12	37.27±3.3	1.34±0.28	m	36.42±1.7	1.17±0.16	m
	13	35.62±5.1	1.30±0.16	m	33.63±2.6	1.2±0.18	m

容怀疑地该条染色体上的异染色质量是增加了，这也许是常染色质的转化到异染色质增加的一个例证。同时，鉴于它的染色体着丝粒区C⁻带发达并具有较多端粒C⁻带，与同属另三种相比，宝兴齿蟾的C⁻带核型可能反映了较进化的性质。

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CYTOTAXONOMICAL STUDIES ON CHINESE PELOBATIDS IV. THE KARYOTYPES AND C-BANDS OF FOUR SPECIES IN THE GENUS *Oreolalax*

(Plate Ⅰ)

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Abstract

The karyotypes and C-bands of 4 species, *Oreolalax omeimontis*, *O. pingii*, *O. popei*, and *O. rugosa* are reported for the first time. All these species have the same diploid number, 2n=26, consisting of 5 large (nos. 1-5), 1 medium (no. 6), and 7 small (nos. 7-13) chromosome pairs. There is a secondary constriction at the long arm of chromosome no. 6 in all 4 species. The karyotypic formula of this genus is quite similar to that of *Vibrissaphora*. C-banding shows that *Oreolalax* has less advanced constitutive heterochromatin than other genera in more advanced families of Anura. C-banding techinque reveals heteromorphism in chromatin in the secondary constriction of chromosome no. 6 in *O. popei*, in which one chromatin is much larger than the other, suggesting that a euchromatin may have transformed into a heterochromatin.

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脆蛇蜥的染色体组型、C-带和Ag-NORs研究

（图版Ⅱ）

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蛇蜥类动物主要分布于热带美洲。在我国蛇蜥动物的种类不多，其中脆蛇蜥是分布较广的一种，除四川、云南和贵州有分布以外，江苏、浙江、广东、广西和福建等均有记载。近几年来，在安徽也有发现（安徽师大生物系，1978）。本文所研究黄山产的脆蛇蜥(*Ophisaurus harti* Boulenger)的染色体组型、C-带带型和Ag-NORs，以期对脆蛇蜥的遗传进化、分类地位等的研究提供参考。

材料和方法

脆蛇蜥(3♀，2♂)采自安徽黄山浮溪。

1. 染色体标本制备 以骨髓细胞和肠组织细胞为材料，采用常规空气干燥制片法。

1.1 骨髓制片：实验动物腹腔注射秋水仙素溶液(5-8微克/克体重)。5-8小时后取适量脊椎骨，用0.4%KCl溶液冲洗骨髓细胞，直接低渗20—30分钟，然后离心(1000转/分)，弃上清液。再用甲醇与冰醋酸(3:1)的固定液固定15分钟，重复固定2—3次。常规滴片，晾干后用1/10Giemsa液(0.15M磷酸缓冲液稀释，pH6.8)染色30-40分钟，水洗，晾干。

1.2 肠组织制片：在取骨髓的动物上取适量肠组织剪成碎片，0.25%胰蛋白酶(0.7%NaCl溶液配制)室温消化2-3分钟。然后用生理盐水洗入离心管内，稀释至适当体积，离心(1000转/分)后弃上清液，留下沉淀物作进一步处理，具体步骤与骨髓制片法相同。

标本制成后，显微镜(10×100)下观察计算二倍体染色体数目。统计数据系由10个细胞的放大照片上测得。由于脆蛇蜥有相当多的小染色体，不便测量，因此相对长度的计算以每号染色体长度占大型染色体总长度的百分数计。着丝点位置的确定按Levan et al.(1964)标准。染色体缩写符号按常用的爬行动物染色体命名法，即V代表中部或亚中部着丝点染色体；I代表端部着丝点染色体，m代表微小染色体。

2. C-带显带 按Sumner(1972)的BSG方法稍加修改：即将标本在0.2NHCl室温处理30分钟，经蒸馏水洗后移入新配的5%Ba$(OH)_2 \cdot 8H_2O$ 8-10分钟，再于60℃下2×SSC温浴60分钟，最后用5%Giemsa液染色20分钟即成。

3. Ag-NORs染色 按改进的Howell和Black(1980)方法进行(施立明，1984)。

结 果

1. 染色体组型 脆蛇蜥的染色体数目

本文承陈壁辉教授审阅，特此致谢。
本文于1987年3月4日收到。

Table 1 The chromosomal number of *Ophisaurus harti* Boulenger

Number of animals		No. of cells observed	Diploid chromosome number						
			34	35	36	37	38	39	40
♀	3	73	2	2	1	3	61	2	2
♂	2	65	1	1	3	4	56	3	0
Total		138	3	3	4	7	114	5	2
%			12.32				82.61	5.07	

Table 2 The measured data of macrochromosome of *Ophisaurus harti* Boulenger

Acc. No	Relative length	Arm ratio	Centromere ratio	Centromere position
1	19.73±0.35	1.62±0.16	38.24±0.20	V
2	17.99±0.26	1.39±0.13	41.94±0.16	V
3	16.63±0.14	1.39±0.15	41.86±0.10	V
4	15.28±0.17	1.72±0.09	36.71±0.11	V
5	12.57±0.08			I
6	10.64±0.21	1.39±0.11	41.82±0.08	V
7	7.16±0.16			I

和大型染色体的测量结果见表1和表2。染色体组型如图版Ⅱ，*A*、*B*所示。脆蛇蜥二倍体染色体数($2n$)为38，可分成大型染色体(macrochromosome)和微小染色体(microchromosome)两组。

大型染色体组：共7对(No.1-7)，相对长度为7.16-19.73之间。其中5对属中部或亚中部着丝点染色体(No.1-4，No.6)，2对是端部着丝点染色体(No.5和No.7)。各相邻染色体对间相对长度均有较明显差异。容易区别。

微小染色体组：包括No.8-19染色体。

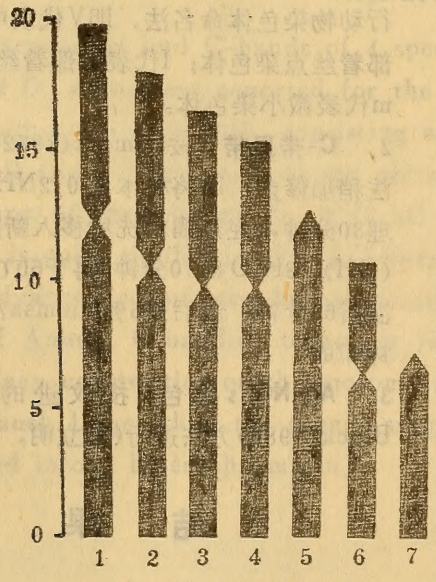

Fig 1 The idiogram of macrochromosomes of *O. harti* Boulenger

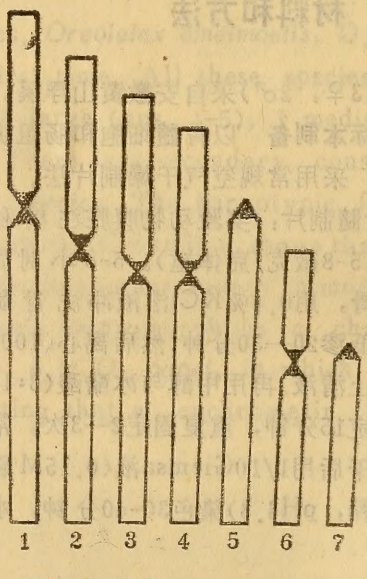

Fig 2 The idiogram of C-banding pattern of macrochromosomes of *O. harti* Boulenger

按照一般分析爬行类动物的微小染色体惯例，该组均以单臂染色体计。

染色体总臂数N.F.=48(V具2臂，I和m具1臂)，其染色体组型可表示为

10V+4I+24m

大型染色体模式图如图1所示。未见有形态上可辨认的异型性染色体。

2. 脆蛇蜥的C-带和Ag-NORs C-带染色结果表明，脆蛇蜥的结构异染色质位于染色体上的着丝点区，核型的全部染色体均显示出着丝点(centromere)C-带，其中大型染色体的No.2-4和No.6显示深染C-带，而No.1、No.5和No.7为浅染C-带；微小染色体也表现有染色深浅程度的差异（图版Ⅱ，C、D及图2)。

银染结果，发现脆蛇蜥呈现两对清晰而稳定的NORs，均位于小型染色体上，初步定为No.8和No.11染色体上（图版Ⅱ，E)。在被分析的20个Ag-NORs染色的中期分裂相中，有7个No.11（按我们初步排列）上的NORs呈现出姊妹染色单体间联合。

讨　论

1. 染色体组型 从结果分析可知脆蛇蜥$2n$=38，N.F.=48，染色体组型(10V+4I+24m)有以下几个主要特点：(1)染色体组中含7对大型染色体和12对微小染色体，属于两型核型(Bimodal Karotypes)。脆蛇蜥的这种两型核型情况与蜥蜴目多数动物是相似的。(2)根据已有报道，蜥蜴目的二倍染色体数目一般为22-46，其中大多数蜥蜴$2n$=36。Morescalchi(1976)认为$2n$=36是蜥蜴类中的较原始状态。脆蛇蜥显示的情况与此类核型接近。(3)蜥蜴类动物存在性染色体分化的复杂性，其中包括无形态上可辨认的异型性染色体，如中国石龙子（吴美锡，1983)、鳄蜥（吴贯夫等，1981）以及King(1977)曾报道在已经研究过的蜥蜴目15个科的染色体组型中，有8个科（除个别种外）均无在形态上可辨认的异型性染色体。其次，是雌雄异型性染色体蜥蜴，它们有雄性异型(XY♂/XX)；雄性异型复合体(X_AX_BY♂/$X_AX_AX_BX_B$)和雌性异型(ZZ♂/ZW)等。用Giemsa染色的一般染色体组型分析中，未发现脆蛇蜥有异型性染色体。属于在形态上无可辨认的异型性染色体核型。

2. 结构异染色质和核仁组织者(NORs) C-带技术是显示染色体结构异染色质区的主要方法之一。许多研究结果表明，结构异染色质主要分布在着丝点区。现已知道结构异染色质具有种的特异性，可以从一个侧面识别物种，并进一步探讨其亲缘关系。目前，关于蜥蜴类的C-带的报道不多(Moritz 1984等)。

有学者(Schmid,1978a；Zuiz等,1981)认为，在生物进化过程中，结构异染色质是一种能促进核型进化的遗传结构。染色体的断裂首先发生在结构异染色质区，因为它没有结构基因，所以在核型变异过程，通过结构异染色质区发生染色体重排对个体不产生严重的危害。对蜥蜴类来说，如果产生染色体重排，在C-带显示时就可能有插入型C-带或端型C-带。因为蜥蜴类核型演化的主要趋势可能为大染色体由端部着丝点向中部着丝点染色体发展，或微小染色体由多变少，相应的大染色体由少变多（李树深等，1981)。因此，在较进化的核型中，主要是中部或亚中部着丝点染色体，而染色体的插入型C-带和端型C-带也许部分是端着丝点染色体和微小染色体的原始着丝点的结构异染色质的痕迹。Hsu和Arrighi(1971)在哺乳类研究中曾设想过整条染色体易位后，由钝化的着丝点附近的异染色质构成插入型C-带。但是从本文的实验结果表明，脆蛇蜥仅显示着丝点C-带，即从C-带型上表明其染色体核型的相对稳定性。

银染技术是特异显示NORs的有效方法之一，已经证明Ag-NORs即18s+28srRNA

基因的分布区。在本文的实验中，发现脆蛇蜥有两对Ag-NORs，它们都分布于微小染色体上。Howell(1977)认为，银染的染色体位点代表与rDNA活性有关的蛋白质。Schmid(1980)在对众多的两栖类进行研究以后，进一步指出，银染方法对于有丝分裂中期染色体来说，只是那些在间期有转录活性的NORs能被$AgNO_3$特异地染色，而活性弱或无活性的NORs则不能用$AgNO_3$显示。因此，利用Ag-NORs能反映出它在间期核中的转录活性特点，人们已经把它做为细胞分类学的重要指标，在核型及其比较研究中，Ag-NORs不仅反映了rRNA基因的染色体定位，而且通过观察它的染色变异性可了解rRNA基因数目的不同或活性的差异。我们在银染适当的脆蛇蜥的间期核里能看到1-2个棕色的大核仁，它们是NORs在间期核里的反映。

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STUDIES ON THE KARYOTYPE, C-BANDS AND Ag-NORs OF *Ophisaurus harti* BOULENGER

(Plate Ⅱ)

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Abstract

The diploid number, 2n, of the glass lizard, *Ophisaurus harti* Boulenger, is 38, consisting of 7 pairs of macr- and 12 pairs of microchromosomes. Among the macrochromosomes, Nos. 1-4 and 6 are metacentric, and Nos. 5 and 7 acrocentric.

The karyotype formula may thus be shown as 10V+4I+24m, and N.F is 48. No heteromorphic chromosome is observed in the karyotype.

C-bands of various shades are found in all chromosomes. The Ag-NORs observed are located on 2 pairs of microchromosomes, Nos. 8 and 11. Moreover, Ag-NORs association between sister chromatids was observed on 7 chromosomes of No. 11 during metaphase.

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花背蟾蜍受精卵中原核重建的细胞学研究

（图版Ⅱ）

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关于受精过程中原核重建（pronuclear reconstruction）的问题迄今很少报道，Longo研究海胆雄原核膜的来源，认为80%来自卵的内质网，但从受精卵发育的不同时期认识两性原核重建的形态变化，在两栖类未见有详细的报道。为进一步认识原核重建中的核、质关系，选用花背蟾蜍受精卵，对其原核的重建作细胞学研究。

材料和方法

选用兰州地区优势种花背蟾蜍（*Bufo raddei* Strauch）的本种受精卵。4月份是花背蟾蜍的自然繁殖季节。在繁殖期从野外采取性成熟的个体，在室温21℃下人工授精。按卵子受精后发育时间的不同，分为13组，分别是：未受精卵、受精15、25、35、40、50、55、65、75、85、95、105、115分钟的受精卵。每组有9-12个受精卵。上述材料均用巴德荣（Bataillon）固定剂固定、石蜡包埋，连续切片，片厚7μ，用番红、亮绿染色，最后镜检照象。

实验结果

未受精卵的细胞核均位于动物极近中部的皮层，呈第二次成熟分裂中期象（图版Ⅱ，1），与豹蛙的情况完全一样。在受精卵的第二次成熟分裂纺锤体活动过的皮层区，可见一条由着色大红的卵黄颗粒组成的明显标记，自皮层直达雌原核显现处，此即雌性原核迁移道。

受精15分钟时，精子已入卵内，但尚位于皮层浅部，其周围有许多色素颗粒。棒状的精子在清亮区，头部略有膨大。着色深红，呈酸性反应（图版Ⅱ，2）。此时，卵母细胞核呈第二次成熟分裂后期象。受精25分钟时，精子原有形态已经消失，精子入卵时自动物极皮层表部带入卵内的色素颗粒，成为雄性原核活动去向的天然标记，此色素带即精子穿入道的标记。追踪精子穿入道的深部，其末端呈嫌色性的半清亮区，高倍镜下此区见有细丝样的网状结构，着色淡红，是此刻雄原核染色体的表现形式。半清亮区的边周聚集有一些小泡及色素颗粒（图版Ⅱ，3）。此刻，卵核处于第二次成熟分裂末期，一半染色体已排出卵皮层，即第二极体。另一半留于卵内，成为雌原核的染色体（图版Ⅱ，4）。35分钟时，雄原核在半清亮区开始出现断续不全的核膜，核膜外周附有单层排

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列的色素颗粒、小泡以及少量红色杆状体和卵黄颗粒。这样，构成了雄性原核的雏形。初成的雄性原核多呈橄榄状，核内染色质呈淡青色，显弱酸性，多在偏动物极的卵黄球间。此时，尚未见到雌性原核。45-55分钟时，雄性原核轮廓已十分清晰，在切面的不同部位，核膜形成比较完整，核膜外周小泡及色素颗粒显著减少，核内染色体着色淡绿，显弱碱性。由于双层核膜的逐渐形成，并包被了核物质，核膜与其周围的卵黄之间开始出现了扩大的半清亮区（图版Ⅲ，5）。随着受精时间的延续，雄性原核逐渐移到卵的深部；45分钟以后，出现雌性原核。初成的雌性原核位于动物极浅层，被卵黄及色素颗粒紧紧包围，呈椭圆形，着色浅淡，不见核膜，隐约可见其内部有着色淡红的丝状物（染色体），与初成的雄性原核颇为相似（图版Ⅲ，6）。随着受精的进程，渐渐向雄性原核活动的半清亮区移动，内含丝状物的着色逐渐由淡红色变为淡绿色，但核物质着色变性的速度略慢于雄性原核。65分钟时，双层的雄性原核核膜形成得更加完整，核内染色体显碱性。核外周的半清亮区域更加扩大。75分钟时，雌性原核膜形成，有的雌性原核移入雄原核活动的半清亮区，但多数雌性原核位于卵细胞动物极深部。此期，两性原核几乎都显碱性反应（图版Ⅲ，7）。受精85-95分钟时，半清亮区内的两性原核正在相结（图版Ⅲ，8）。105分钟时，两性原核已部分融合，有的已能看到融合核内的染色体，呈淡红色，显酸性反应。核内其它的物质呈弱碱性反应。

讨　论

两性原核重建过程中，无论从核膜的形成还是从核蛋白质由酸变碱的速度上，雄性原核总是快于雌性原核，这是由于雌性原核的重建起始于精子入卵15分钟以后，此刻，精核已进入核膨大的重建期。但只有当雌性原核在形态和性质上发育到与雄性原核基本相同的程度，两性原核才开始相结并融合。精子入卵后，精头开始膨大，随之变成一堆疏松的核物质，分散于细胞质的一定区域，染色体的嗜碱性大为减弱。25分钟后，这些分散的核物质重新凝聚，出现嗜酸性的染色体。原核边周开始出现断续的核膜，核膜出现的同时，附于核外周的小泡、色素和卵黄颗粒减少了，这些附着物可能参与了核膜的重建，对此尚需作进一步研究。原核活动的半清亮区域的扩大，为两性原核的相结与融合提供了条件。雌性原核在核膜的重建及核蛋白质的变性上与雄性原核基本相同。在受精后35-45分钟时，未能见到雌性原核，原因是此时核内的染色体着色与卵黄颗粒颇难区别，且分散于卵黄颗粒间，核膜重建前，颇难辨认。

原核运动的机理，曾有许多报道。60年代，Longo和Anderson用透射电镜观察到精子星体内有微管的存在；80年代，Harris等利用微管蛋白抗体进行了间接免疫荧光法的观察。目前认为精子在卵内的移动是由于星体内微管的作用，而且认为雌原核定向运动的启动，也赖于精子星体内微管蛋白的聚合和解聚的平衡上。还有认为雌原核在沿着精子星体微管蛋白滑动。但花背蟾蜍受精卵中，未曾见到精虫星光，两性原核运动的动力，尚待研究。

两性原核重建过程中，核蛋白质在酸、碱性质上的变化与草鱼受精卵中的所见基本一样。利用氢银反应，在仓鼠受精卵上测出了核蛋白性质上的酸、碱变化。这对我们从受精的细胞化学上探讨此一问题可作借鉴。

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A CYTOLOGICAL STUDY ON THE PRONUCLEAR RECONSTRUCTION IN THE FERTILIZED EGG OF *Bufo raddei*

(Plate Ⅱ)

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Abstract

At the time of fertilization, the egg of *Bufo raddei* is in meiotic metaphase Ⅱ, and the spindle is located in the cortex, near the centre of the animal pole. The sperm nucleus can be observed at the end of the sperm penetration path marked by pimant granules. 15 minutes after fertilization, the sperm nucleus starts to decondense and migrate towards the centre of the egg. A semitransparent area, which later becomes the site of fusion between the male and female pronuclei, will appear around the male pronucleus during its reconstruction. The female pronucleus can readily be found at the end of the female nuclear migration path marked by yolk granules. The female pronucleus reconstructs at a lower speed than does the male pronucleus. During pronuclear reconstruction, both male and female pronuclear proteins turn from acidity to alkalinity.

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闭壳龟属一新种——金头闭壳龟

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目前世界上已报道的闭壳龟共有6种，即安布闭壳龟*Cuora amboinensis*(Daudin)，黄缘闭壳龟*C. flavomarginata*(Gray)，黄额闭壳龟*C. galbinifrons* Bourret，潘氏闭壳龟*C. pani* Song，三线闭壳龟*C. trifasciata*(Bell)云南闭壳龟*C. yunnanensis* (Boulenger)，分布于我国中部及南部，以及自缅甸向东，北达日本，南至印度尼西亚等东南亚各国。我国产后5种*。

笔者在1985年10月及1986年10月，获得来自安徽省南陵县的闭壳龟标本3号，经研究，与上述6种均有明显差异，确认为一新种。

金头闭壳龟 *Cuora aurocapitata* Luo et Zong，新种（图1-2）

鉴别特征：新种与潘氏闭壳龟*C. pani*相近似。但潘氏闭壳龟背甲扁平，正中线上隐有脊棱；颈盾细小；第三、五椎盾长宽相等，二、三肋盾等长；喉盾沟为肱盾沟的1.5倍，胸、腹盾沟比肛盾沟长；腹甲后缘缺刻明显。眶径与吻长相当。头背橄榄色，头侧暗灰色，有二条褐纹从眼后达颈部；鼓膜淡灰色，下喙及喉部灰黄色。体背淡褐色，腹部黄色，有黑色宽纹位于盾片相接处，并连成一整体。而新种金头闭壳龟*Cuora aurocapitata*背甲较隆起，脊部较平，脊棱明显；颈盾短小，钟形；三、五椎盾宽均大于长，喉盾沟为肱盾沟的1.5至2.5倍；肛盾沟最长，胸、腹盾沟次之；腹甲后端微缺；眶径明显大于吻长。头金黄色，头侧略带黄褐色，具三条黑线纹。最上一条黑线纹从吻端经鼓膜上方达颈部；中间一条短，仅位于鼓膜前上缘；下条自口角沿鼓膜下方达颈部。鼓膜、下喙及喉部、咽部均为金黄色。体背黑褐色，腹部黄色，有左右基本对称的大黑斑，腹甲前叶五块大黑斑呈梅花形。

模式标本：正模标本87Ⅱ012号，雌性成体；副模标本，87Ⅱ011号、87Ⅱ010号，雄性幼体。模式标本由当地农民吕三宝采于南陵县丘陵地区的溪边石堆中。模式标本保存于上海自然博物馆。

头大小适中，头背平滑。吻略突出于上喙，上喙微曲，下喙短于上喙。眶径大于吻长。背甲卵圆形，前后缘圆，背甲较隆起，脊部较平，正中线上脊棱明显，无侧棱。颈盾短小，钟形；椎盾五枚，第一椎盾五角形，前缘中央向前突出，前缘较后缘宽；二、三、四椎盾基本为六边形，宽均大于长；第五椎

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* 有的作者，如S. B. McDowell(1963)和赵尔宓(1986)，把*Cuora flavomarginata*(Gray)归入*Geoemyda*属。赵尔宓（1987）认为，海南闭壳龟*Cuora hainanensis*（Li）即为黄额闭壳龟*Cuora galbinifrons* Bourret，但也有人持不同意见，有待进一步证实。

本工作在研究、鉴定过程中，得到中科院成都生物研究所赵尔宓研究员、江跃明付研究员、安徽师范大学陈壁辉教授、复旦大学黄正一付教授、南充师范学院邓其祥付教授、徐州师范学院生物系周寿昌主任及上海自然博物馆王惠基、倪月玲等同志的大力支持和帮助，并请上海自然博物馆曹末元同志摄照，在科研经费上，得到徐州市科协的资助，均此致谢。

本文于1987年8月12日收到。

盾扇形，宽大于长。肋盾四对，第一肋盾外缘长，内缘短；第二肋盾最大，长方形，宽大于长；第三肋盾五边形，宽大于长；第四肋盾最小。缘盾12对。第一缘盾较宽；三至五缘盾，七至九缘盾微上翻；均为四边形，宽大于长。腹甲略短于背甲。腹甲前端圆，后端微缺，与背甲以韧带相连系；胸腹盾之间亦有韧带相连，腹甲前后两部分能完全闭合于背甲。喉盾沟是肱盾沟的1.5至2.5倍，肛盾沟最长，其后依次递减为胸盾沟、腹盾沟、喉盾沟、股盾沟、肱盾沟，最短为肱盾沟。肛盾2片，四肢背面覆以覆瓦状排列的鳞片；腹面内侧鳞较细小，前肢腹面有一横列的大鳞片；后肢内侧被细鳞、蹠部鳞片较大。前肢五爪，后肢四爪。指、趾间有发达的蹼。尾较短，圆锥状，背面被细鳞，后段鳞片成对；腹面被成对鳞片，正中有一纵沟；雄性尾较细长，泄殖腔孔离基部稍远。

生活时头为金黄色，头侧略带黄褐色，有三条细黑纹。一条从吻端向后，在眶处中断，经鼓膜上方达颈部，中间一条短，位于鼓膜前上缘；下面一条自口角处沿鼓膜下方达颈部。鼓膜黄色，下嚎及喉、咽部黄色。颈背褐色，其腹面及肩部、腋下均为黄色。背甲黑褐色，鳞片接缝处明显色深。第二至第五枚椎盾棕红色，幼体在第二肋盾下缘各有一棕红色小斑，成体在相应部位亦有一浅色斑。腹甲黄色，左右盾片均有基本对称的大黑斑，在腹甲前叶及肛、股盾处的黑斑尤为明显。前叶的五块大黑斑组成梅花形，87Ⅱ011号标本肱胸盾缝上的黑斑连成横带。四肢背面灰褐色，外侧缘有一条黄色纵线，腹面及胯、股部亦为黄色。爪褐色，末端色稍浅。尾背有三条黑色纵纹，中间一条短，不明显，腹亦黄色。

图1 背视♀，. 87Ⅱ012.

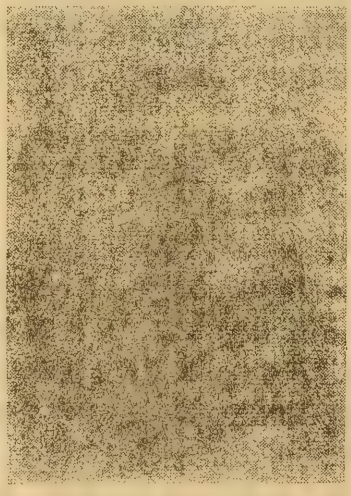

图2 腹视，♀. 87Ⅱ012.

金头闭壳龟，新种*Cuora aurocapitata*, Sp. nov.

模式标本量度 （单位：mm）

模式标本	性别	头长、宽、高	吻长	眶径	间距	背甲长、宽、高	壳高与壳长之比	腹甲长、宽	尾长
正模87Ⅱ012	♀	27.5×20.8×13.7	6.4	8.9	9.3	138.6×92.6×50.8	36.7%	136.1×72.8	50.9
配模87Ⅱ011	♂	24.4×14.3×9.8	4.9	5.9	7.5	89.3×65.6×29.2	32.6%	81.9×46.4	35.0
87Ⅱ010	♂	23.7×14.7×11.6	6.0	6.5	7.9	91.7×65.7×32.4	35.3%	87.9×47.2	31.2

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A NEW SPECIES OF *Cuora*—*Cuora aurocapitata*

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Abstract

Cuora aurocapitata sp. nov.

Holotype: SMNH 86Ⅱ012, an adult female.

Paratypes: SMNH 87Ⅱ010-011, two male young.

All the type specimens were collected from Nanling County, Anhui by a peasant in October, 1985 and 1986 and are preserved in the Shanghai Museum of Natural History.

Diagnosis: The new species is closely related to *C. pani* but differs by the possession of, carapace more convex while flattened at top with a prominent vertebral keel; nuchal small, bell-shaped; third and fifth vertebrals broader than long; suture between gulars 1.5-2.5 times as long as that between humerals, which is the shortest; suture between anals the longest; plastron slightly notched at posterior end; snout shorter than orbit; head golden, brownish on the side, with three black thin streaks; second to fifth vertebrals red-brown; second costal with a spot (red-brown in young and lighter in adult); plastron yellow, with largely symmetric large, black patches; front lobe with 5 large black patches.

Length of shell 89.3-138.6mm, breadth 65.7-92.6mm, and depth 29.2-50.8mm.

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SEA TURTLES IN FUJIAN AND GUANGDONG PROVINCES

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ABSTRACT

Five species of marine turtles occur in Fujian and in Guangdong Provinces, where a survey of the coast was carried out between June and August 1985. Details of morphometrics, scalation, other body characteristics, and epizoa are given for each species. The major age classes recorded were: *Caretta caretta* - subadults; *Lepidochelys olivacea* - adults and subadults; *Chelonia mydas* - adults; *Eretmochelys imbricata* -subadults; and *Deriacea*-adults and subadults. Nesting is reporetd to have once occurred throughout these two provinces, but the only significant nesting known to occur now is by *C. mydas*, and most of that is in the Xisha Island. with the exception of *C. mydas* which is fished intensely in the Xisha Islands, incidental capture during offshore fishing operations is the source of nearly all turtles. Most catches are made during the summer and autumn. Beaches, reported to have once had nesting, are now subjected to so many perturbations that virtually no nesting

This article reports the results of a cooperative project between: Fujian Teachers University, Fuzhou, China; National Program for Advanced Study and Research in China, CSCPRC; and National Academy of Sciences, Washington D. C., USA. Major responsibilities are as follows: Senior sponsorship and obtaining permits (particularly in Fujian—Professor Ding Hanbo; Obtaing permits and logistical planning and support—Zheng Ji; Negotiations and obtaing permits in Guangdong, logistical planning—Huang Zhujian; Translations and Interviews—Lu Ling; Assisting in data gathering, analysis, and writing of preliminary and final reports—Susana Salas Frazier; Data gathering and analysis, scientific planning, and writing of preliminary and final reports—John G. Frazier.

turtle can escape back into the sea. The few inshore marine areas observed suggest that there is little feeding habitat for *C. mydas* or *E. imbricata*. It was virtually unanimous among fishermen and other coastal peoples that populations of sea turtles have declined tremendously over the past few decades, and attitudes toward the animals have changed from traditional respect and protection to contemporary full-scale exploitation. There is a great need for long-term, detailed studies—even of basic biology; and there is an urgent need for rational conservation and management of these valuable renewable natural resources and their requisite habitats. The present rate of exploitation on the Xisha Islands will soon result in the wholesale destruction of natural resources there.

INTRODUCTION

There are some 7 or 8 species of sea turtles (Cheloniidae and Dermochelyidae) living today, and these include some of the largest of all extant reptiles, as well as some of the most economically valuable of wild animals. Marine turtles represent much appreciated sources of proteins, oils and other products that have been used for nutritional and medicinal purposes for centuries. Some marine turtle products (e. g. tortoise-shell and leather) are much sought after in industrialized nations and as a result these command high prices and earn foreign exchange in areas where income is generally low. The effect on the turtles is very heavy exploitation. As a rarely broken rule, marine turtle populations around the world have been overexploited and their numbers catastrophically reduced-particularly during the last few decades (Frazier 1980; Bjorndal 1982).

In addition, human populations have increased dramatically over the last decades in most countries, and as a result coastal and marine habitats have come under heavy pressure from exploitation of natural resources and from modification of habitats for agricultural and socio-economic development. As a consequence, requisite nesting and feeding habitats for marine turtles in many parts of the world have been destroyed or so greatly altered that they do not provide the requirements of the animals.

A further factor which greatly complicates the situation is that all sea turtles have highly complicated life cycles, depending on a variety of habitats from terrestrial to epipelagic ecosystems, and requiring decades to reach maturity. In the course of a normal life cycle a single sea turtle, during its development, may travel over vast areas of ocean; once it is mature the turtle may make seasonal migrations of thousands of kilometres across coastal waters and open ocean. Hence, during its lifetime, an individual turtle will pass through and live in many sovereign territories. Despite half a century of detailed scientific study by biologists in dozens of countries, many basic biological points about sea turtles remain unknown (Fra-

zier, 1984a).

As a consequence, biologists, naturalists and people concerned with the rational use of natural resources are dedicated to the study of marine turtles so that mankind can better benefit from a more thorough understanding of the biology and natural history of these intriguing animals and so that we can benefit from *rationnal* utilisation of these natural resources—in such a way that future generations will be able to enjoy these natural treasures, and not suffer from the greed and mismanagement of former generations. This concern is world-wide, transcending national boundaries.

The goals of the project described herein were to make available basic information on marine turtles in a poorly studied area; assist in the conception, planning and guidance of management and conservation programs; and assist in technology transfer for field, analytical and management procedures.

ITINERARY and METHODS

The survey began on 6 June 1985 in Fujian province, where two weeks were spent, using 3 bases: Shishi, Zhangpu, and Dongshan. During this time 15 coastal sites were visited; 28 interviews were carried out; 6 potential nesting areas were visited; and 13 specimens were examined (of which 10 were collected).

From 19 June until 2 July and from 19 July until 27 July the survey was based on the mainland of Guangdong Province. Seven different bases were used; 4 coastal sites were visited; 12 interviews were carried out; one nesting area was visited; and about 16 specimens were examined (of which 3 were collected).

Hainan Island was surveyed between 2 July and 19 July. Four bases were used; 7 coastal sites were visited; 15 interviews were carried out; 6 potential nesting areas were visited; 3 potential feeding habitats were visited; and 102 specimens were examined (of which 10 specimens and additional stomach contents and limb bones were collected).

From 9 to 12 August, the survey continued on Pingtan Island, Fujian, where: 6 coastal sites were visited; 4 interviews were carried out; one potential nesting area was visited; and 19 specimens were examined (of which 7 were collected).

During the various stays in Fuzhou 39 specimens were examined, of which 31 were in the Department of Biology, Fujian Teachers University and 8 in the Fujian Provincial Museum.

Identifications of specimens were based on information in Frazier (in press) ; measurements are as described in Frazier (1984b). Abbreviations used in the text are listed in Appendix I. Interviews with coastal fishermen and others were conducted using the standard format in Appendix Ⅱ (omitted).

RESULTS

The results are treated in 3 parts: Specimens, Habitat Surveys, and Interviews.

SPECIMENS

Specimens of 5 species were examined, totaling 189 individuals. Only 4 of these were live. The vast majority of specimens were carapaces (of *Chelonia mydas* especially) that remained after the animal had been killed and consumed. In all but one instance the specimens were easily identified to species; the exception was a small and badly weathered fragment of a carapace (for comments on identification of sea turtles see Frazier, in Press).

Caretta caretta (Linnaeus)—Xi Gui, Loggerhead Turtle.

Specimens examined - A total of 16 specimens (and a fragment of another specimen thought to be of this species) were examined: FTU=6; FPM=2; Fujian fishermen=5; Hainan fishermen=3.

Distribution-The species was recorded from Hainan Island (19° 40'N) to Pingtan Island (25° 30'N); 81% of the *C. caretta* were from Fujian and only 19% from Guangdong. Of all the Fujian specimens examined, *C. carette* comprised 23%; of all the Hainan Island turtle specimens examined, *C. caretta* comprised only 3%. No *C. caretta* from the Guangdong mainland were seen. Hence, the species is more commonly captured in the north than in the south (more than half of the specimens of this species came from Pingtan Island alone).

Seasonality - The species is caught through much of the year; records span from March to October, with 3 Hainan specimens in late June/early July and 4 Fujian specimens in October. The few data suggest that in the south the species is caught more commonly in the summer and in the north, more commonly in the autumn, but more data are required to establish seasonal trends.

Morphometrics - Curved carapace length of 16 specimens ranged from 74.5 to 102.5cm ($\bar{X}$ ±1 St. Dev.=82.0 ±6.88cm) (Figure 1). Less than half of the animals were greater than 80cm, so most of the sample were evidently subadults. Curved carapace width varied from 88 to 97% of CCL, averaging 91.4%(±2.56%; N=15). Depth of the supracaudal notch varied from 1.0 to 2.8% of the CCL, averaging 1.8% (±0.46%; N=15). Head width varied from 19 to 21% of CCL, averaging 19.4% (±0.67%; N=9). Plastron length varied from 69 to 76% of CCL, averaging 72.7% (±2.46%; N=9). Length of the postanal scale varied from 2.1 to 7.6% of the PL, averaging 3.9% (±2.06%; N=7).

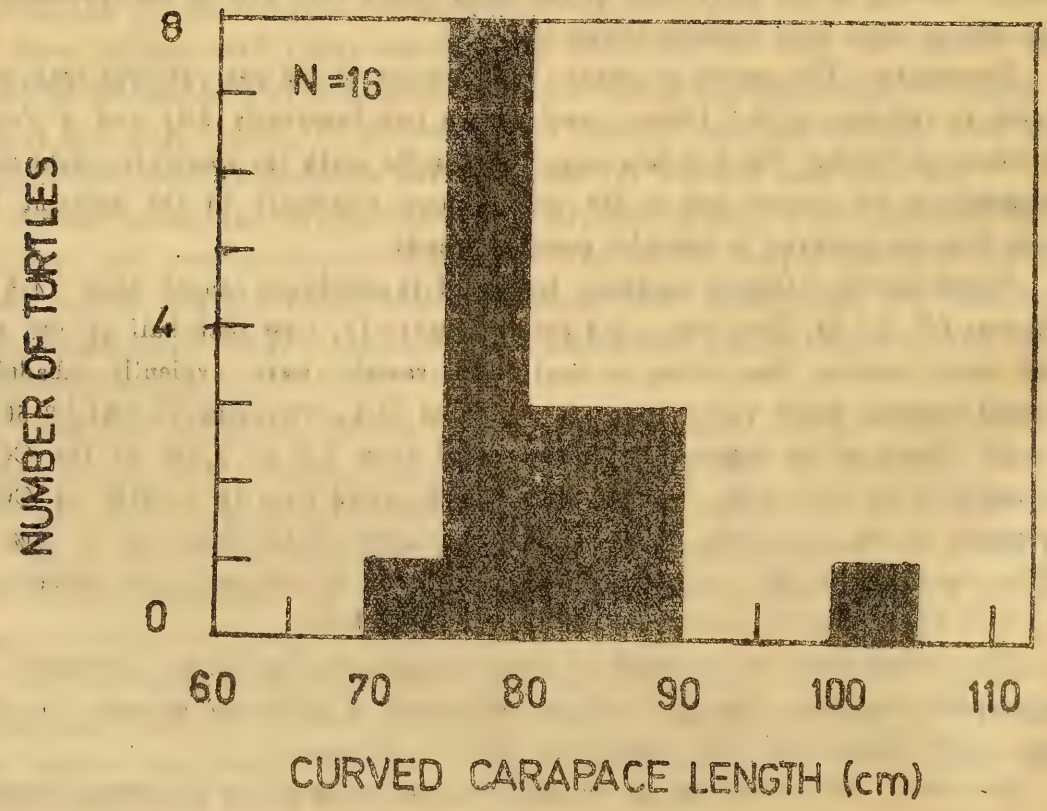
The sample sizes are too small to make conclusions about sexual differences or ontogenetic variation, although there are indications of allometric decrease in relative: CCW (Figure 2), HW (Figure 3), and PL (Figure 4).

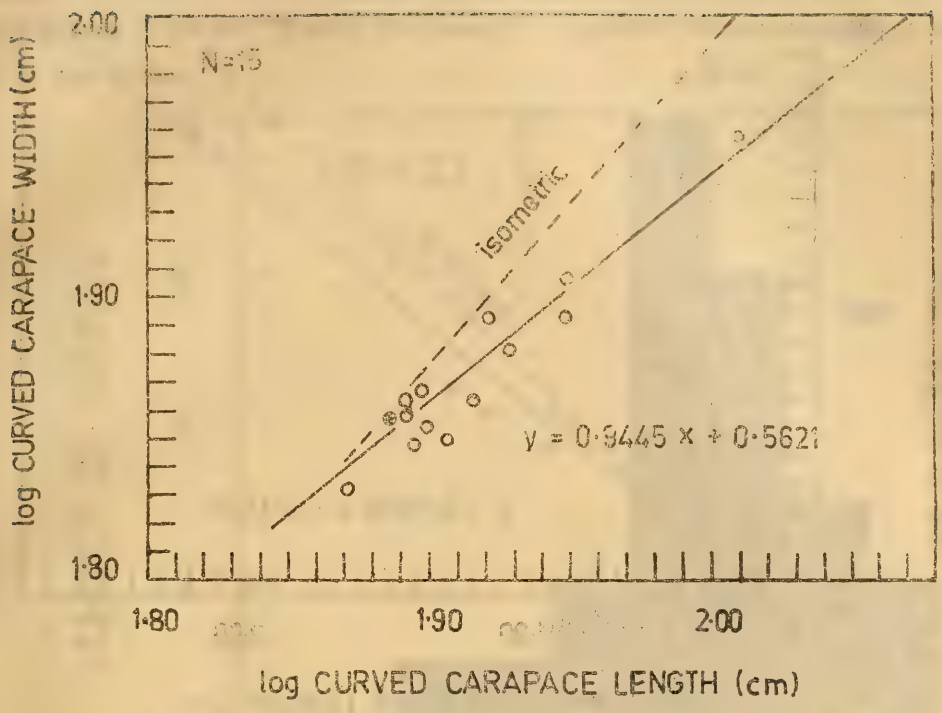
Scalation - Only one of the 15 specimens showed variation in the normal number

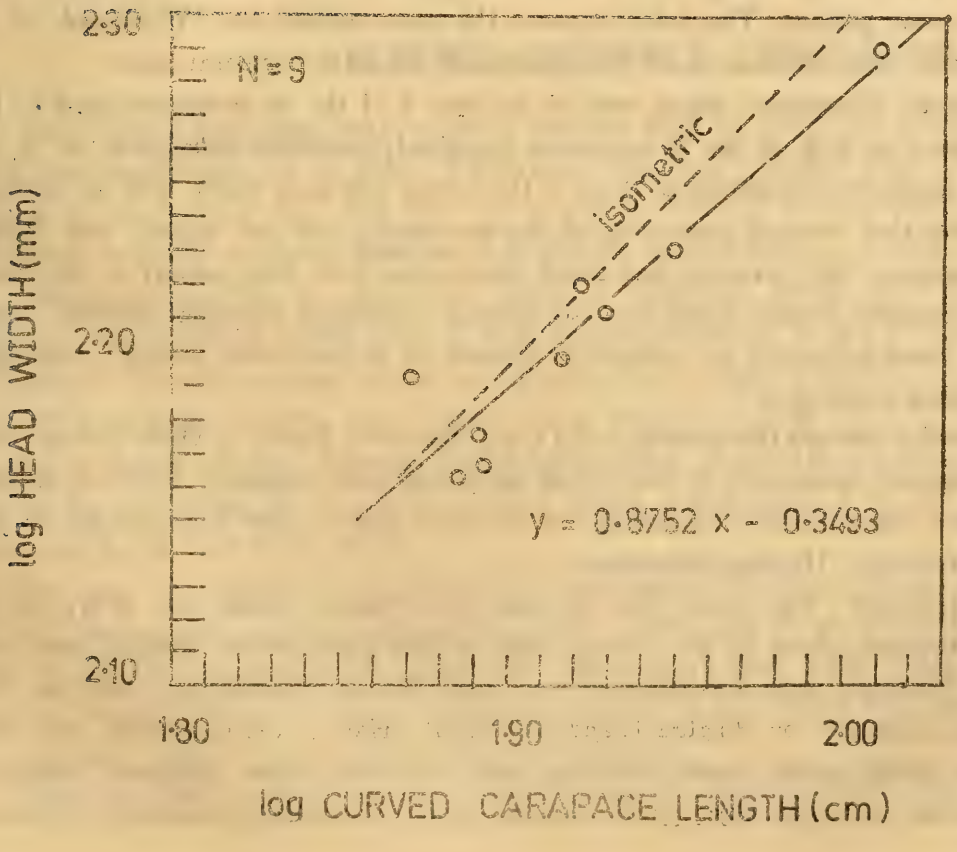
of vertebral scutes; it had 6 instead of the usual 5. Variation in the number of pleural scutes was greater; 12 specimens each had 5 pairs of large scutes; 2 specimens each had a greatly reduced 1st right pleural; one specimen had 4 right and 5 left pleurals; and one specimen had 6 right and 5 left pleurals. Hence, 25% of the specimens had abnormal right pleurals; no specimen had abnormal left pleurals. Marginal scutes were relatively variable; 6 specimens each with 11 pairs; one specimen with 10+1 partially divided left and 11 right; 3 specimens each with 12 left and 11 right; 3 specimns each with 12 pairs of marginals. Hence, more than half of the sample had non-modal conditions(*viz.* other than 11 pairs of marginals). One of the 11 specimens had a divided cervical scute; in 12 others it was single.

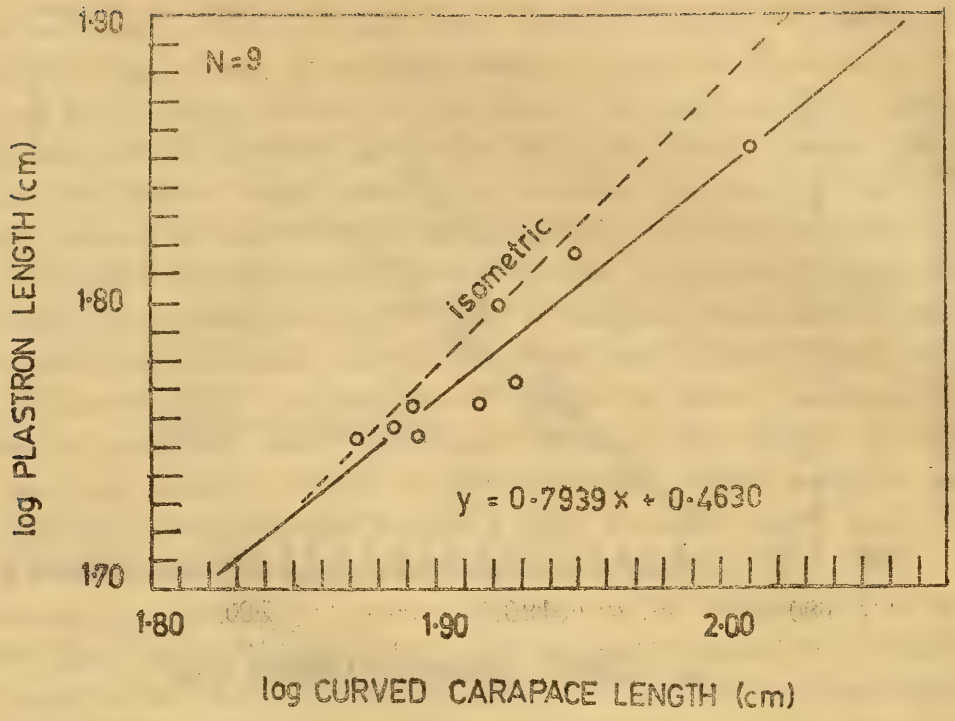
Head scalation also shows considerable variation. The number of postocular scales was most frequently 3 pairs (7 of 9 specimens). Other conditons were; 4 pairs, and 2+1 partially divided left and 4 right. prefrontal scales varied from 4 to 8 in number, with 5 being most frequent (4 of 9 cases).

Inframarginal scutes were 3 pairs in the majority of specimens (8 of 9); the exception had 4 pairs. The intergular scute was much reduced in comparison to other species in the Cheloniidae; it was absent in 4 cases and very small (less than 1/4 of a gular scute) in 4 other cases. The submandibular scales, that cover the ventral surface of each ramus of the mandible, were always greater than 1 in number; each side of the jaw had either two large elliptical scales with a much smaller




2·00
1·90
1·80
log CURVED CARAPACE WIDTH (cm)
N=15
isometric
y = 0·9445 x + 0·5621
1·80
1·90
2·00
log CURVED CARAPACE LENGTH (cm)


2·30
2·20
2·10
log HEAD WIDTH (mm)
N=9
isometric
y = 0·8752 x - 0·3493
1·80
1·90
2·00
log CURVED CARAPACE LENGTH (cm)



circular scale between them; or 3 large rounded scales of nearly equal size.

Other morphological features, difficult to quantify but characteristic of this species, were present. The notch between the supracaudals was "V"-shaped. A pygeal "knob" was conspicuous at the anterior of the fifth vertebral scute.

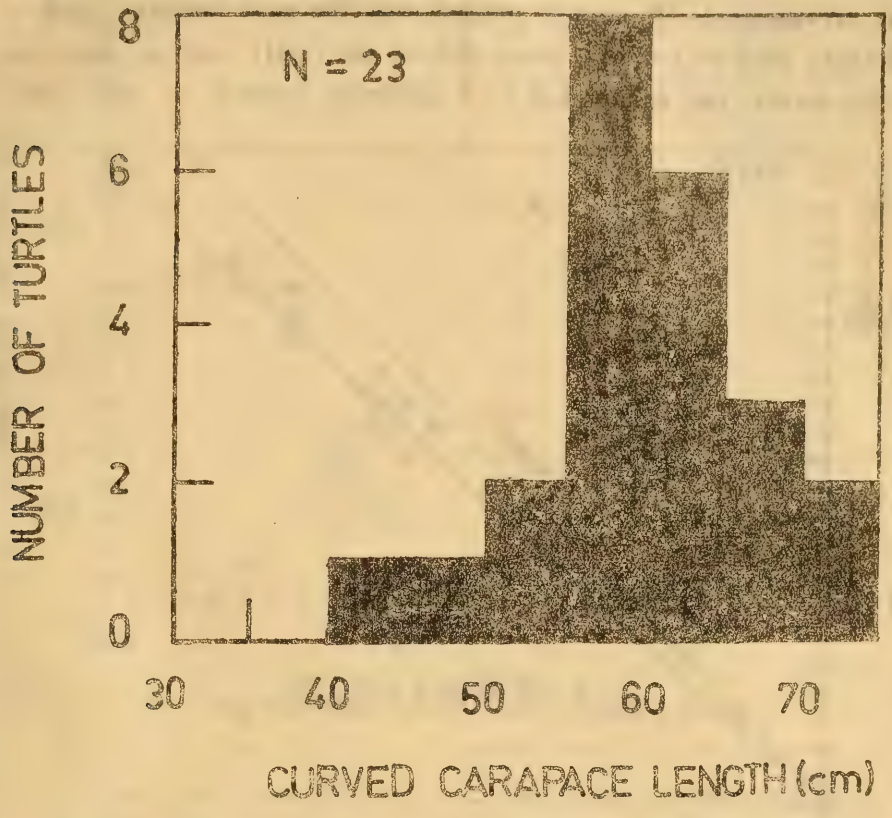
Epizoa - Filamentous algae were on at least 4 of the 16 carapaces (25%). Barnacles were on 50% of the 16 specimens examined: *Chelonibia testudinaria* on 3, burrowing barnacles (*Stomatolepas* ?) on 4 (including one male turtle with an extensive infestation that covered about 80% of the carapace), and one animal had *Platylepas hexastylos*. One carapace had small depressions with what appear to be macroscopic copepods within. These rates of epizoan occurrence represent minimal values, because these organisms are frequently cleared off of specimens during preparation for museum collections.

Lepidochelys olivacea (Eschscholtz)—Li Gui ["Beautiful Turtle"], Olive Ridley turtle.

Specimens examined - A total of 24 specimens were examined: FTU=5; DSMS=1; Fujian fishermen=17 (including one carapace said to have been caught in Zhejiang Province); Hainan fishermen=1.

Distribution - The species was recorded from Hainan Island (19° 40'N) to Zhejiang Province (about 27°N). Nearly 92% of the *Lepidochelys olivacea* were from Fujian Province, only one specimen was from Hainan, Guangdong; and one from Zhejiang (captured by Pingtan Island fishermen). Half of the specimens came from Pingtan Island, north Fujian Province, and of all the Fujian specimens examined, *L. olivacea* comprised 31%; of the Hainan Island specimens examined, *L. olivacea*

comprised less than 1%. No turtles of this species were recorded from the mainland of Guangdong Province. Hence, the species is captured more commonly in the north than in the south.



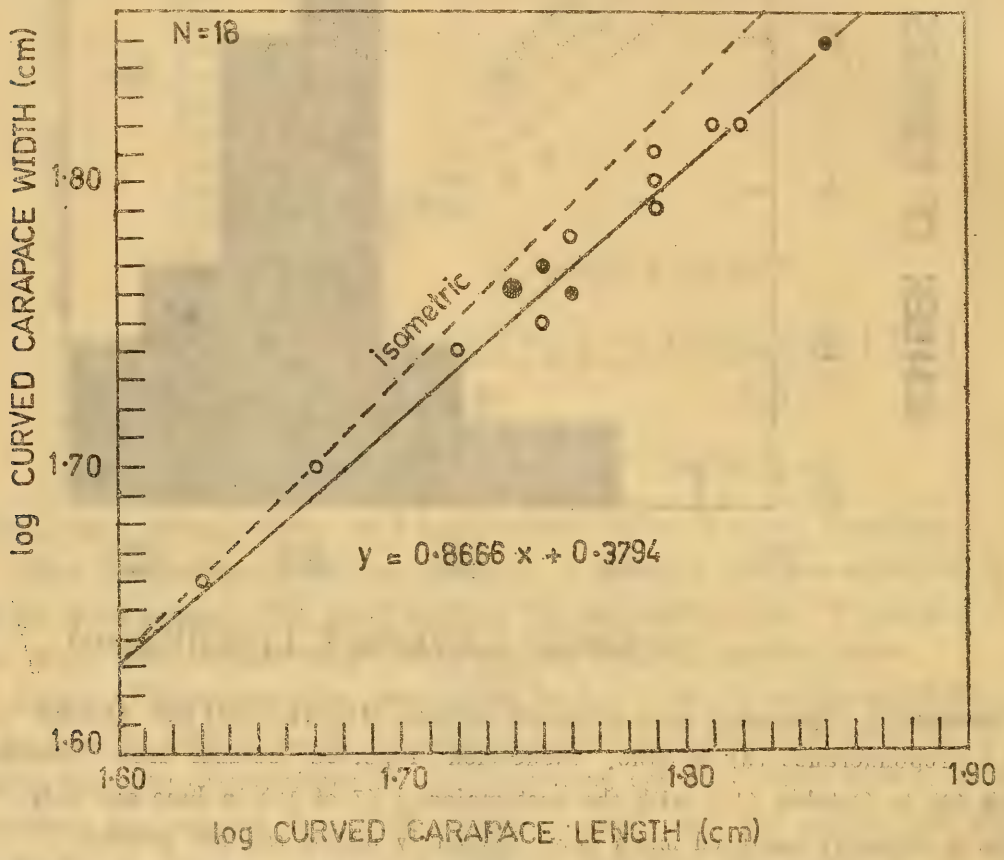
Seasonality - Specimens were collected between May (1 case) and October (1); with a preponderance (3) in June. Fishermen reported catches from February/ March (2) to October (1), with the vast majority (7 of 12) in June and July. The species is evidently captured much more frequently during summer months.

Morphometrics-The 24 specimens measured included adults and subadults. Curved carapace length varied from 43.0 to 70.0cm, averaging 59.3($\pm$6.70cm; N=23) (Figure 5). Curved carapace width varied from 99 to 108% of the CCL, averaging 102.4% ($\pm$2.44%; N=20). Head width varied from 18 to 19% of CCL, averaging 18.2% ($\pm$0.53%; N=5). Plastron length varied from 70 to 75% of CCL, averaging 72.0% ($\pm$2.16%; N=4). Postanal scale length varied from 2 to 3% of PL, averaging 2.5% ($\pm$0.51%; N=3).

The data are insufficient to determine if any sexual differences occur, and they do not indicate any consistent ontogenetic trend. There may be an allometric reduction in relative carapace width (Figure 6), but relative head width (Figure 7) and plastron length (Figure 8) appear to decrease allometrically. More data are needed to determine if these trends are statistically significant.

Scalation-This species shows great variation in carapace scalation. The number

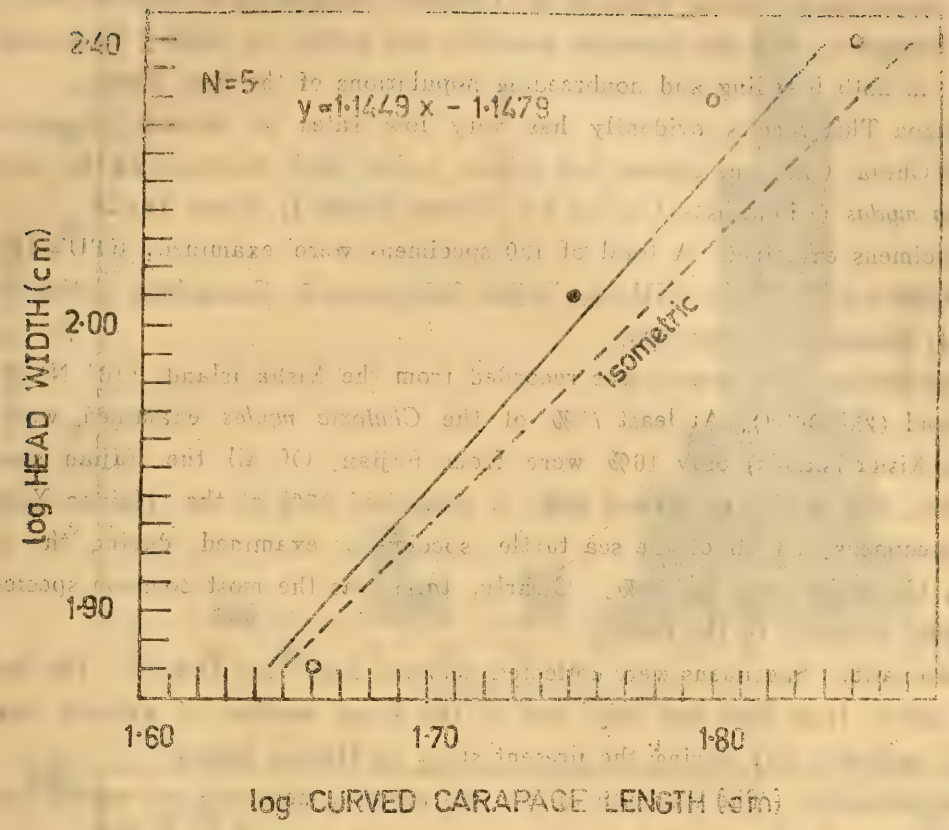
of vertebral scutes varied from 5 to 8 in 24 specimens: 5=25%; 5+1 partially divided=4%; 6=38%; 7=29%; 8=4%. Variation in pleural scutes was even greater; 63% had symmetric arrangements while 38% had asymmetric arrangements. Of the symmetric arrangements, 6 pairs of pleurals was the most frequent (29% of the total), but there were as few as 5 pairs (8% of the total) and as many as 7 pairs (21% of the total); one animal had 5+1 partially divided on each side. Of the

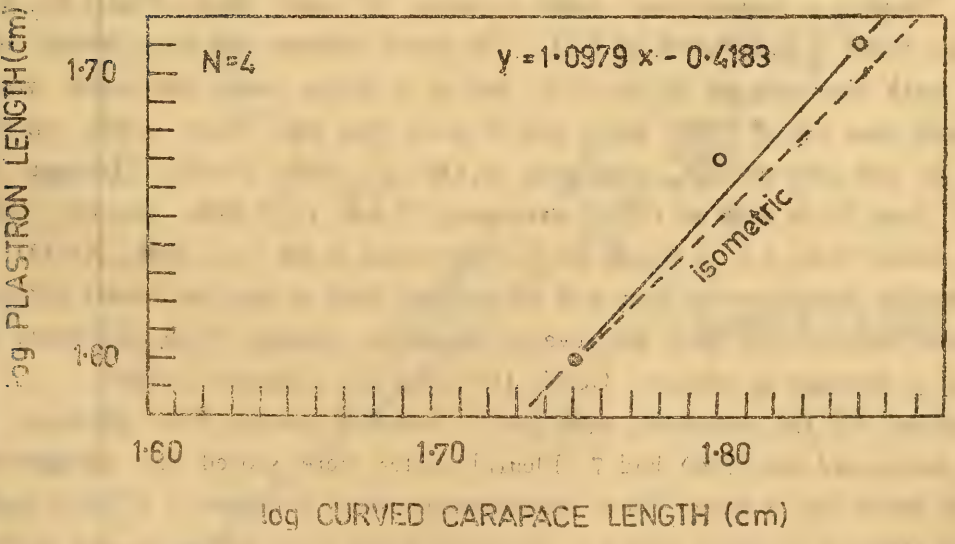


asymmetric arrangements, a greater number of left pleurals was more common than a greater number of right pleurals (25% and 13%, respectively). The greatest number of pleurals on any side was 8 and the least, 5.

Data on marginals are available for only 16 specimens. Of these, 88% had 12 pairs; the remainder had asymmetric arrangements of 12 on one side and less than 12 on the other. Postocular scales varied from 3 pairs to 4 pairs, asymmetric combinations of 3 on one side and 4 on the other also occurred. Data from only 5 specimens are available, and there is no mode.

Inframarginals were 4 pairs and the intergular was small (but data on only 2 specimens are available). There was frequently a pygeal swelling (not a knob) at the level of the last vertebral, and the notch between the supracaudals was normally "C"-shaped. A single, exceptionally large elongate scale covers the anterior ventral surface of each ramus of the mandible. Often there are conspicuous keels on





the neurals at the level of the 1st and 2nd vertebrals.

Other features, common in the East Pacific (Frazier 1984b), were absent. There were never scratches or notches in the anterior "shoulders" of the carapace; nor were there abrasions or gouges on the ventral posterior marginals. These two sorts of injuries are characteristic of breeding turtles and are evidently made by the male

during mounting activities. None of the Chinese *Lepidochelys olivacea* showed a bitonal carapace, with the posterior smoother and lighter in colour. This feature is normal in both breeding and nonbreeding populations of the East Pacific.

Epizoa-This species evidently has very low rates of epizoan infestations, at least in China. Only one animal had epizoa, a few small barnacles on the carapace.

Chelonia mydas (Linnaeus)—Lu Gui (= "Green Turtle"), Green Turtle.

Specimens examined - A total of 130 specimens were examined: FTU=12; FPM =2; DSMS=1; SCSI=4; ZSU=3; Fujian fishermen=6; Guangdong nesting beach= about 4; Hainan fishermen=98.

Distribution - The species was recorded from the Xisha Islands (16° N) to Pingtan Island (25° 30'N). At least 79% of the *Chelonia mydas* examined were from Hainan-Xisha Islands; only 16% were from Fujian. Of all the Fujian specimens examined, this species comprised 30%; it comprised 95% of the Hainan-Xisha Islands specimens. Of all of the sea turtle specimens examined during the present survey, *C. mydas* made up 69%. Clearly, this was the most common species, and it is most abundant in the south.

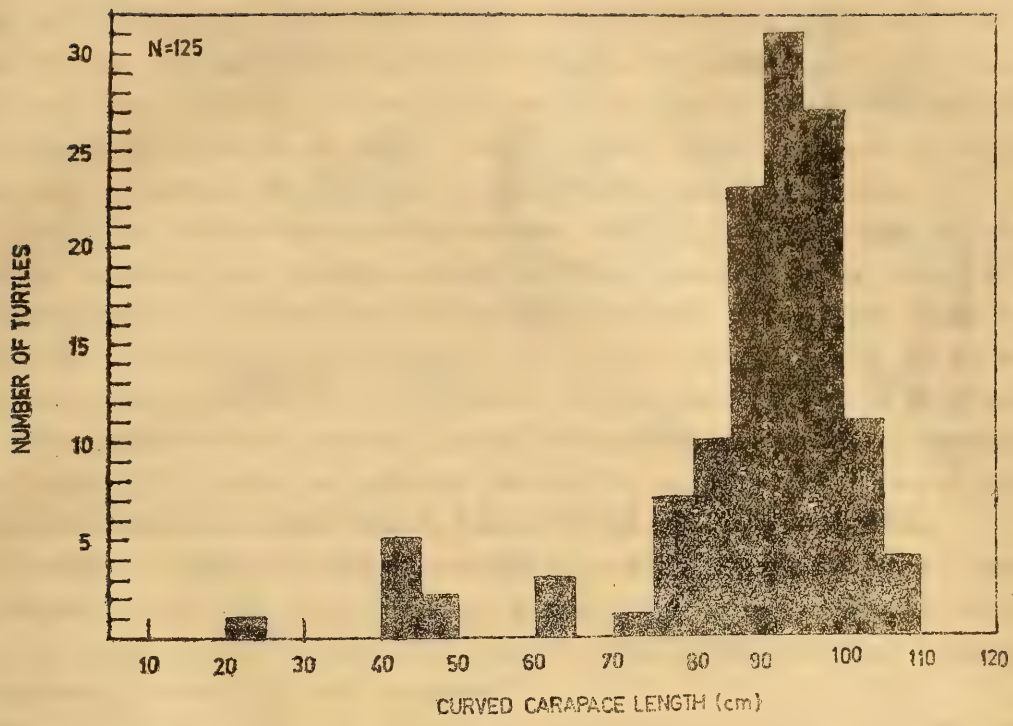
Seasonality - Specimens were collected between April and October. The vast majority were from June and July, due to the large number of animals examined in early and mid July during the present study in Hainan Island.

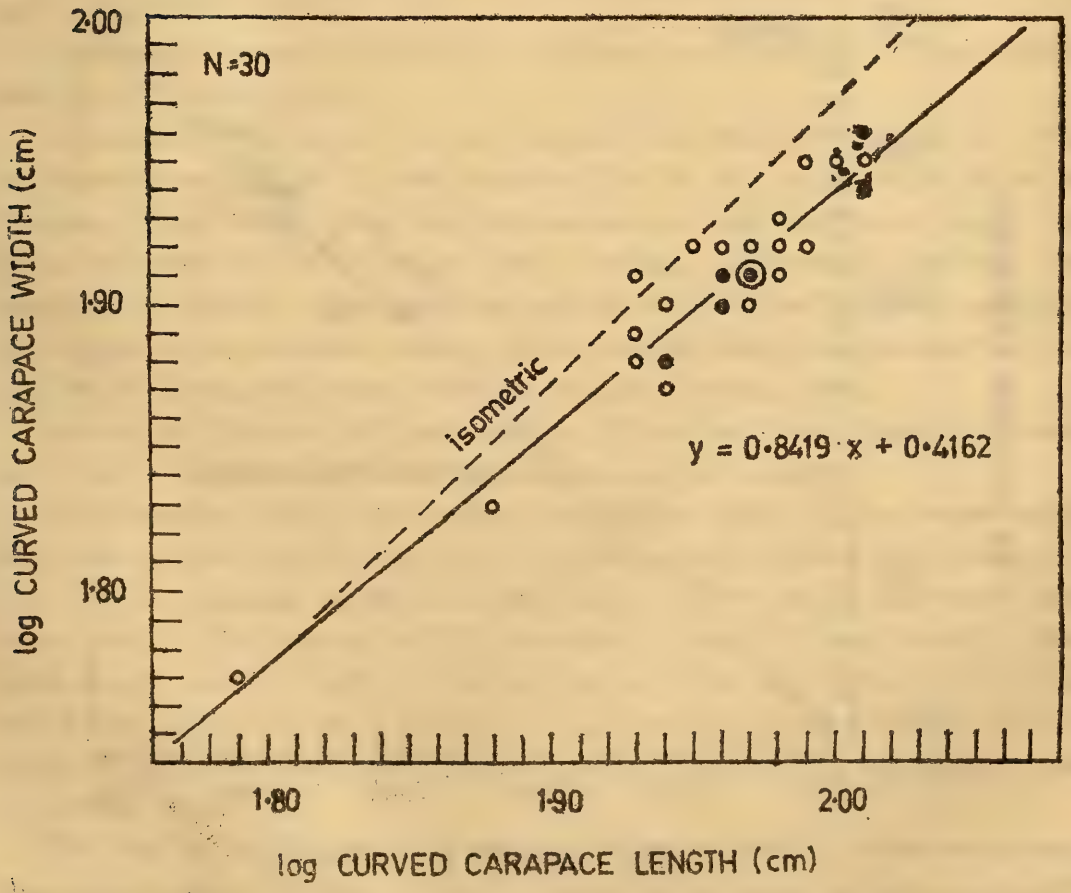
Morphometrics - The majority of the 125 animals measured had curved carapace length between 71.5 and 108.0cm; however, turtles as small as 20.0cm were measured. There is a conspicuous mode between 90 and 95cm (Figure 9). Curved carapace width is about 90% of CCL. The notch between the supracaudals is normally much less than 1% of the CCL, but in a dozen cases the notch was deep and more than 1% of CCL; never was it more than 2%. Head width varied between 13 and 19% of CCL, averaging 13.8% ($\pm$1.36%; N=23). Plastron length varied from 71 to 82% of CCL, averaging 77.9% ($\pm$2.23%; N=33). Postanal length varied from 0.0 to 10.5% of PL, averaging 2.5% ($\pm$1.93%; N=23).

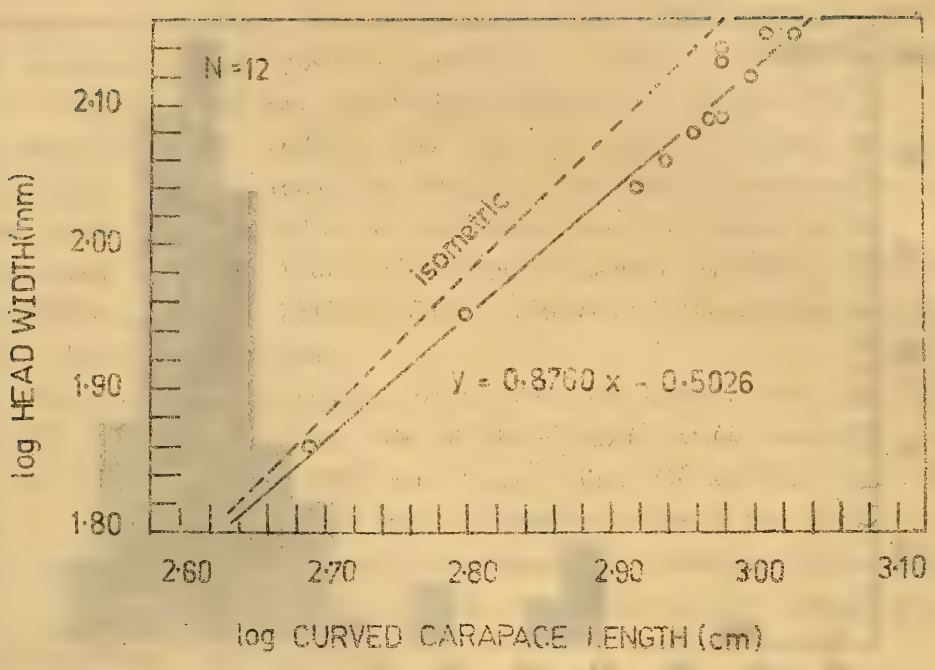
Detailed morphometric data will be analised later to test for sexual differences. The data indicate that there are several allometric changes. With increasing CCL, there is a decrease in relative: CCW, HW, and PL (Figures 10-12).

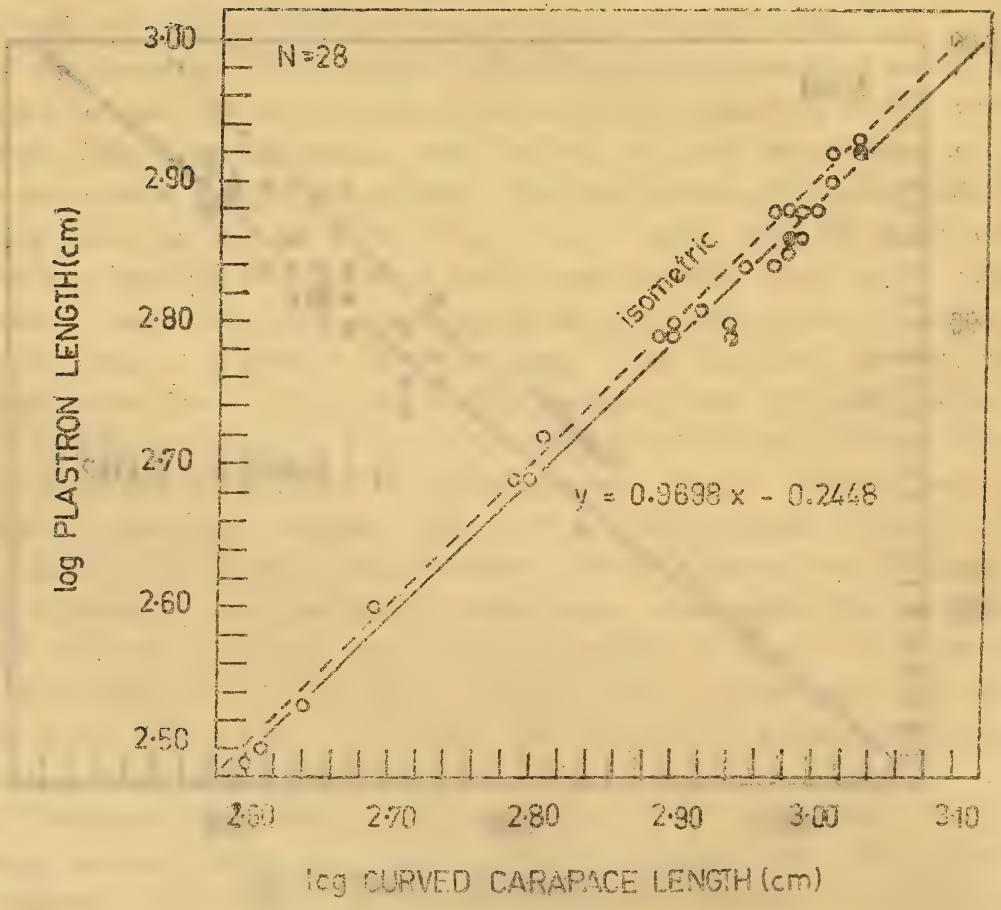
Scalation - Of 123 specimens, 96% had 5 vertebral scutes. Four specimens (3%) had 6 scutes and one (1%) had 7. Pleural scutes were scored for 126 specimens, 95% of which had 4 pairs. Other arrangements were: 5 pairs=1; 5 left/4 right=1; 6 left/5 right=1; 4 left/5 right=3. Marginal scutes were scored for 118 turtles, of which 97% had 11 pairs. Two turtles each had 10+1 partially divided left/11 right, and one had 12 pairs.

Postocular scales were scored for 29 turtles; 76% had 4 pairs. Two had 5 pairs; one had 5 left/4 right; three had 4 left/5 right; one had 2+1 partially divided left/3 right. Axillary scales were recorded for 19 specimens; 42% had 3 pairs;


N=125
NUMBER OF TURTLES
30
25
20
15
10
5
10
20
30
40
50
60
70
80
90
100
110
120
CURVED CARAPACE LENGTH (cm)


N=30
2·00
1·90
1·80
log CURVED CARAPACE WIDTH (cm)
isometric
y = 0·8419 x + 0·4162
1·80
1·90
2·00
log CURVED CARAPACE LENGTH (cm)


N=12
2·10
2·00
1·90
1·80
log HEAD WIDTH(mm)
isometric
y = 0·8700 x - 0·5026
2·60
2·70
2·80
2·90
3·00
3·10
log CURVED CARAPACE LENGTH (cm)


N=28
3·00
2·90
2·80
2·70
2·60
2·50
log PLASTRON LENGTH(cm)
isometric
y = 0·9698 x - 0·2448
2·60
2·70
2·80
2·90
3·00
3·10
log CURVED CARAPACE LENGTH (cm)

21% had 4 pairs; 11% had 2 pairs. Four turtles had 4 left/3 right, and one had 4 left/5 right. Inframarginal scales were scored in 32 turtles; 91% had 4 pairs; two turtles had 4 left/5 right; one turtle had 2+1 partially divided on both sides. In the same 32 turtles the intergular was invariably large. One pair of inguinal scales were present in 22 of 23 turtles; the exception had 2 left/1 right.

Coloration - Information on coloration was collected for 103 turtles. Of these, 70% had concentrations of dark pigment in all large carapace scutes; only 7% had no concentrations in the carapace scutes. The occurrence of red-brown "bulls-eyes" within the concentrations was scored for 97 of the turtles. In 35% the bulls-eye was conspicuous in all scutes; it was absent from all scutes in 49% of the turtles.

There appears to be a sexually related difference in these color characteristics (see Frazier 1971; 1985a), and detailed data will be analised later. There is a clear ontogenetic sequence of color phases, typical of the species in other areas.

Epizoa - On all the specimens examined, filamentous algae were found on only 9 individuals; green, red and brown forms were evident. Barnacles were recorded on only 21 turtles, at least 4 species were present. Four turtles had heavy infestations of burrowing barnacles in their carapaces.

Eretmochelys imbricata (Linnaeus)—Daimei (frequently, but incorrectly called "Daimao"), Hawksbill Turtle.

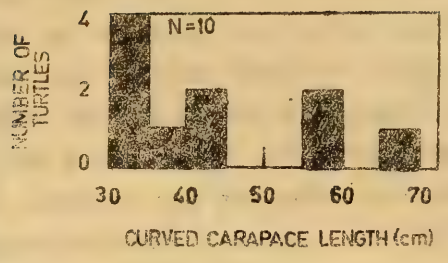
Specimens examined - A total of 10 specimens were examined: FTU=3;FPM=2 (one live); SCSI=4; ZSU=1.

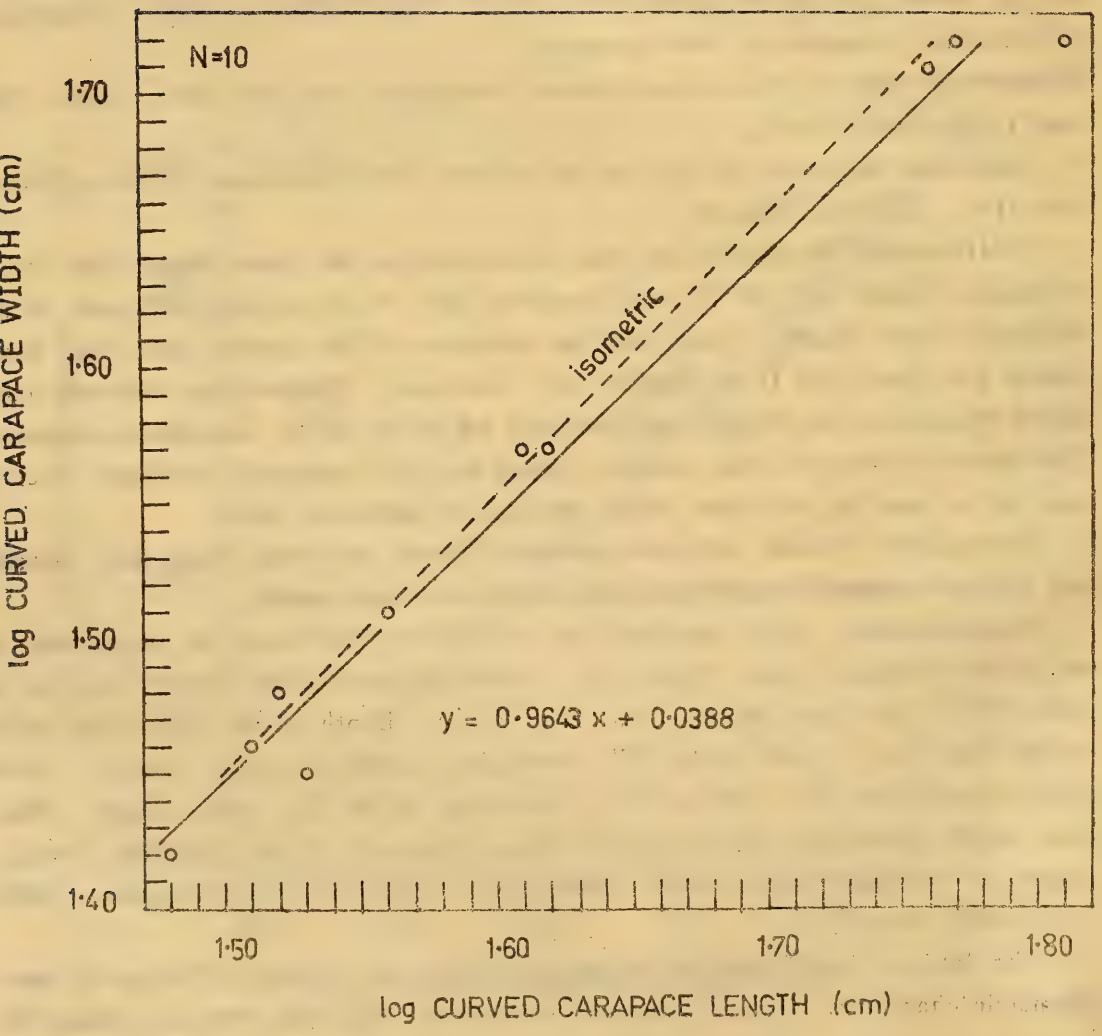
Distribution - The species has been recorded from the Xisha Islands (16° N), to Pingtan Island (25° 30′ N) and Lianjiang (26° 6′ N), on the north side of the Minjiang River, Fujian. About half the specimens of this species were from Xisha Islands and about half from Pingtan and Lianjiang. *Eretmochelys imbricata* comprised 7% of all of the Fujian specimens and 4% of all of the Guangdong specimens. The absence of records from southern Fujian and the Guangdong mainland is curious, but at least in part must reflect the lack of collecting effort.

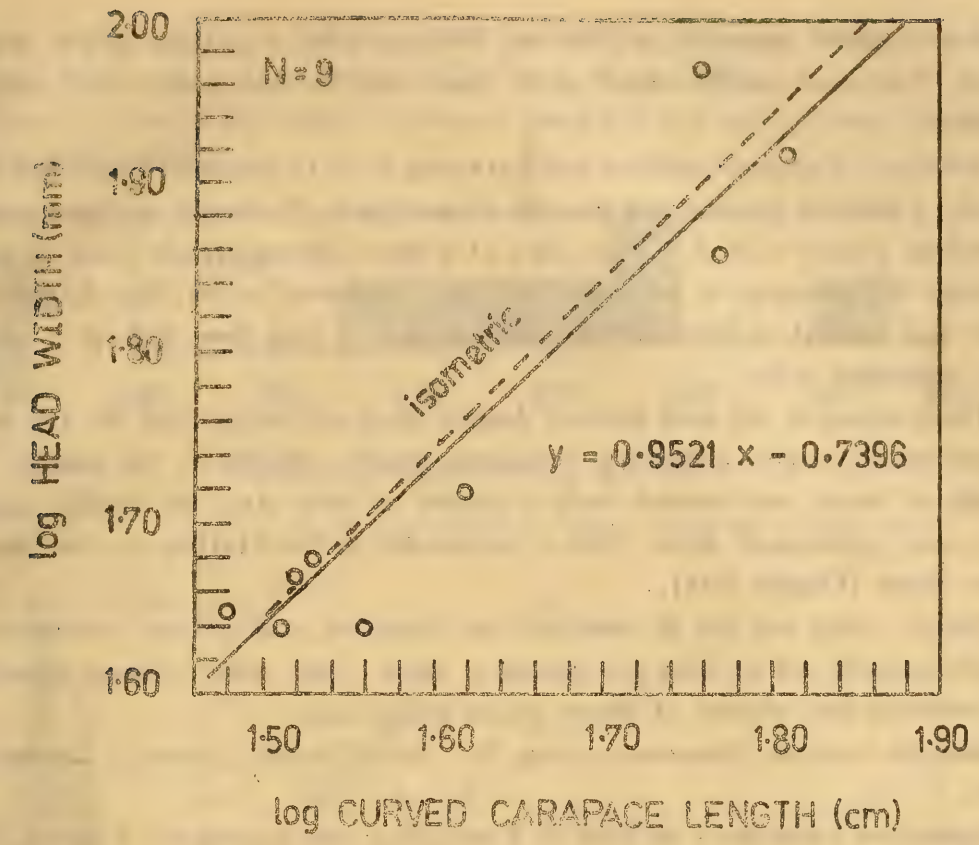
Seasonality - Records (all from northern Fujian) are from: May, July, August and October—summer months with the exception of last named.

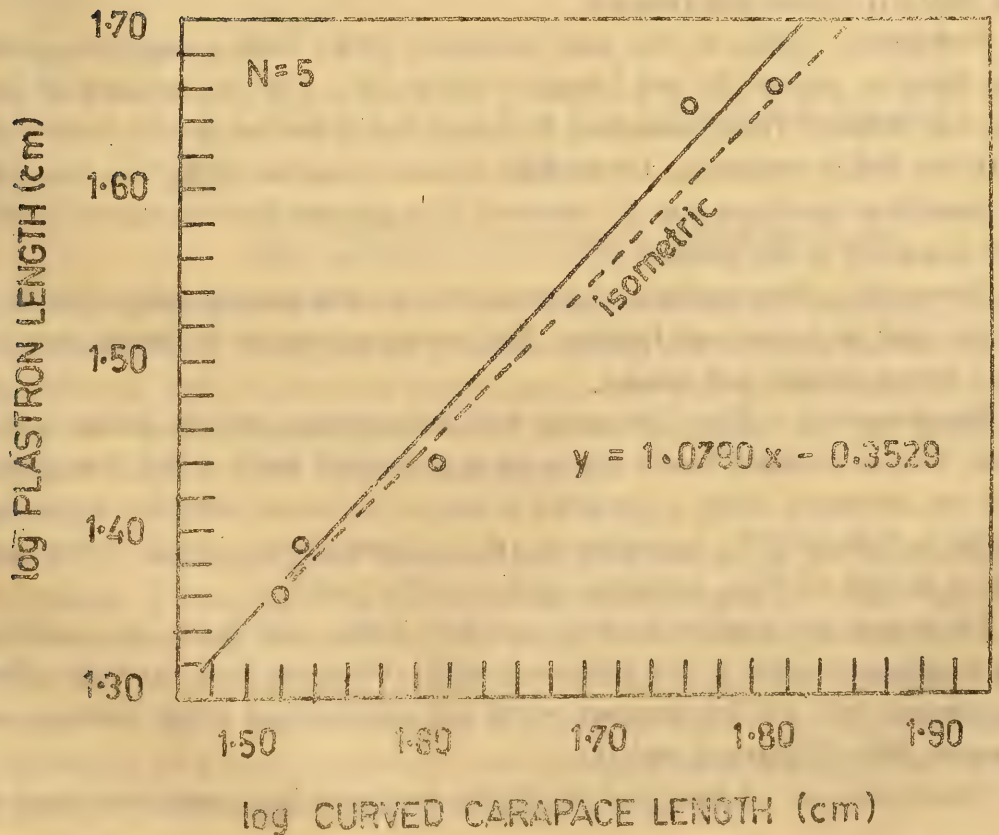
Morphometrics - All 10 specimens are well below adult size; the largest was 65 cm curved carapace length (Figure 13). Curved carapace width varied from 82 to 91% of CCL, averaging 88.2% (±3.12%; N=10). Depth of the supracaudal notch varied from 3.6 to 5.8% of the CCL, averaging 4.8% (±0.77%; N=10). Head width varied from 12 to 16% of CCL, averaging 13.7% (±1.44%; N=9). Plastron length varied from 68 to 79% of CCL, averaging 71.9% (±4.37%; N=5). Length of postanal scale varied from 1.8 to 4.1% of PL, averaging 2.62% (±1.03%; N=4).

The data are insufficient to determine if there are sexual differences in morphometric characters. Several allometric changes are apparent; with increasing CCL


N=10
NUMBER OF TURTLES
4
2
0
30
40
50
60
70
CURVED CARAPACE LENGTH (cm)


N=10
isometric
y = 0·9643 x + 0·0388
log CURVED CARAPACE WIDTH (cm)
1·70
1·60
1·50
1·40
1·50
1·60
1·70
1·80
log CURVED CARAPACE LENGTH (cm)


N=9
isometric
y = 0·9521 x - 0·7396
log HEAD WIDTH (mm)
2·00
1·90
1·80
1·70
1·60
1·50
1·60
1·70
1·80
1·90
log CURVED CARAPACE LENGTH (cm)


N=5
isometric
y = 1·0790 x - 0·3529
log PLASTRON LENGTH (cm)
1·70
1·60
1·50
1·40
1·30
1·50
1·60
1·70
1·80
1·90
log CURVED CARAPACE LENGTH (cm)

there are relative decreases in CCW and HW and relative increase in PL (Figures 14–16). Statistical verification of these trends must be done when more data are available.

Scalation – Carapace scalation was unvarying in all 10 specimens; each had 5 vertebrals, 4 pairs of pleurals and 11 pairs of marginals. Postocular scalation was also unvarying; 3 pairs in 7 of 7 cases. In 6 of 6 cases inframarginals were 4 pairs. Normally the intergular is large and there are 4 prefrontal scales. One animal (JGF 42–87) was unusual in having a very small intergular (less than 25% of a gular) and 7 prefrontal scales.

The position of the most anterior dentate marginal varied from the 4th to the 7th and was inversely related to carapace length. Similarly, the number and strength of dorsal and ventral keels is related to body size; the smaller animals have more prominant keels. This is comparable to the situation in the western Indian Ocean (Frazier 1985).

Epizoa – Only one live *E. imbricata* was examined, and it had two species of balanid barnacle and at least two species of algae. The other museum specimens had evidently been cleaned of epizoa during preparation.

Dermochelys coriacea (Linnaeus)—Leng Pi Gui ("Keeled Turtle"), Leatherback Turtle.

Specimens examined – A total of 9 specimens were examined: FTU=5; FPM =2; ZSU=1; Fujian fishermen=1.

Distribution – Eight of the nine specimens (89%) came from Fujian, between Dong Shan Is. (23°40′ N) and Lianjiang (26°6′ N) . The one specimen in Guangzhou was evidently from Guangdong Province, but it had no specific locality data. Of all the Fujian specimens, *Dermochelys coriacea* comprises 11%; less than 1% of the Guangdong specimens was *D. coriacea*. This suggests that the species is caught more commonly in the north.

Seasonality – Four specimens were collected in May (all in 1984), two in July and one each in August and October. The species appears to be caught more commonly during summer and autumn.

Morphometrics – The 7 specimens with measurements include adults and subadults. Curved carapace length (taken along the medial keel) varied from 115.5 to 152.5 cm, averaging 131.8 (±12.62%) (Figure 17). Curved carapace width varied from 66 to 75% of CCL, averaging 70.4% (±3.30%; N=7). Head width varied from 14 to 16% of CCL, averaging 14.6 (±0.57; N=7).

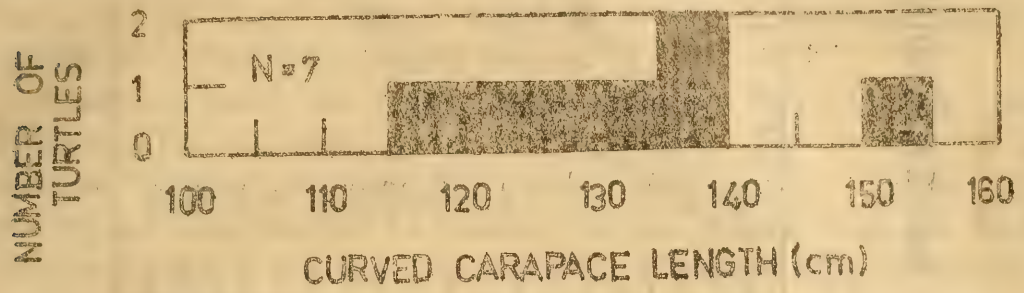
The largest and smallest animals were both males, and there are insufficient data to determine what sexual differences exist. There are clear cases for allometric changes; both relative carapace width and relative head width decrease with increasing CCL (Figures 18 and 19).

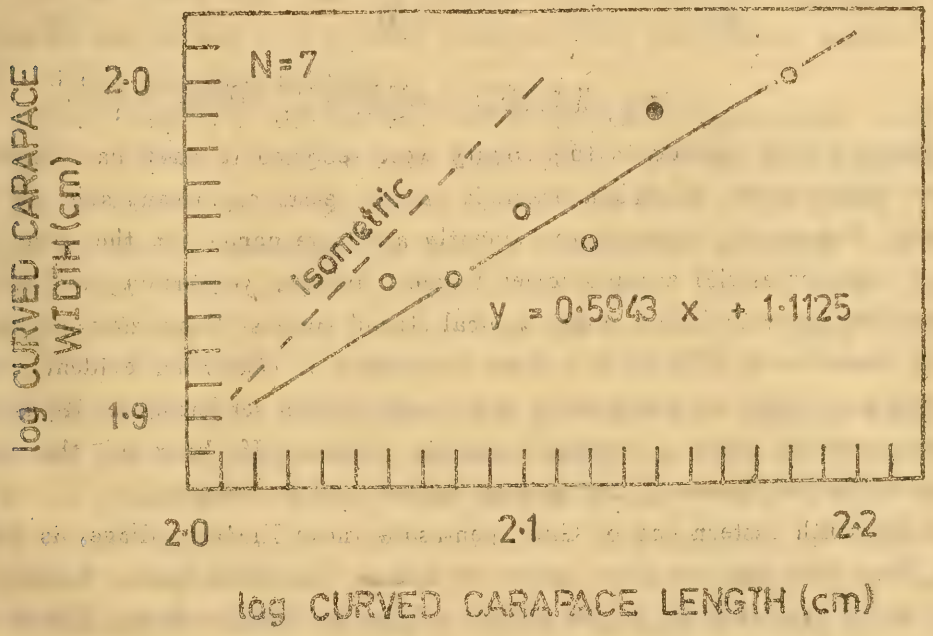
Osteoderms – In at least 3 of the Fujian specimens large osteoderms were con-

spicuous in the anterior of the paramedial keels of the plastron. Small osteoderms in these keels were as far anterior as the level of the axillae.

Epizoa – None of the museum specimens examined had any evidence of epizoa.

HABITAT SURVEYS

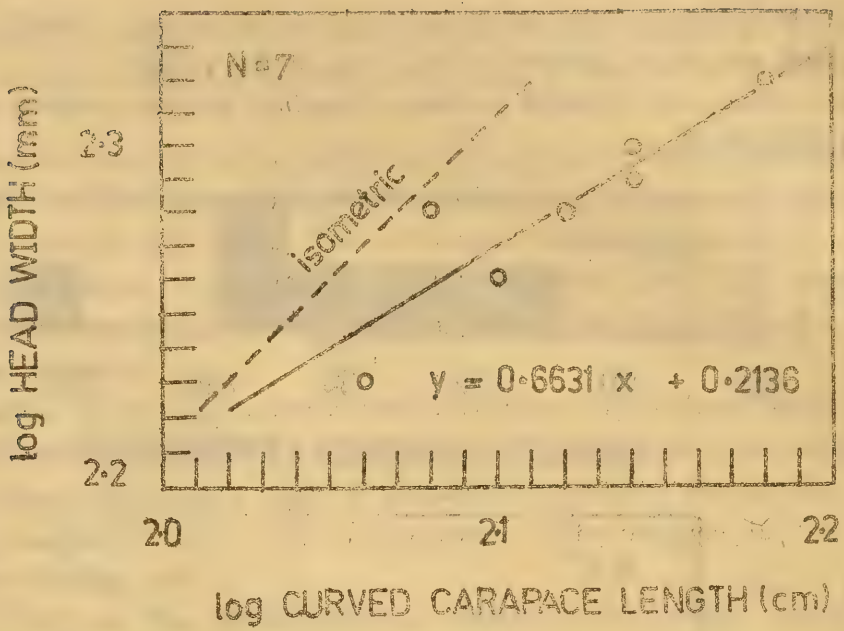




A total of 14 beaches were visited: 7 in Fujian, one on the Guangdong mainland, and 6 on Hainan Island. Three potential feeding habitats were visited—all on Hainan. Although beach visits were brief—usually only half an hour in duration—an attempt was made to assess the status of strand vegetation and the potential value of each beach as a sea turtle nesting habitat.

Fujian beaches

Pingtan – A long sandy beach stretches from Dafu west to Da'ao, on the north east of Pingtan. It was reputed to have once had nesting, some 30 years ago (although it seems that only one nest was ever seen). The intertidal area ends abruptly at vertical cliffs of soil and sand. These cliffs have been, and are, undergoing active erosion. The beach provides poor, if any, nesting habitat. Its badly degraded status appears to be a result of extensive and prolonged sand mining. The Dafu–Da'ao beach is today unimportant as a sea turtle nesting area.



Zhangpu – Five beaches in this county were reported to have had turtles nesting; two were visited. Liaozhua beach is on the east, or ocean, side of Liu'ao peninsula; Xishan and Liaozui are evidently alternate names for the same beach. It has a wide terrestrial area: a lower terrace without vegetation, and an upper vegetated terrace with half a dozen typical strand species. Some 25 to 35 m from the high water mark (HWM) is a dense plantation of *Casuarina*, evidently planted about the year 1980. Although there is a small human settlement at its north end, the beach provides good to excellent nesting habitat. If, however, the *Casuarina* are planted farther seaward, the nesting habitat will be destroyed.

At the south eastern end of Gulei peninsula, near Xia'an village, is Houjiang beach. Here there are low dunes inland of a wide intertidal zone. Half a dozen typical strand species grow on the dunes, helping to stabilize them. Thirty metres inland of the beach is a plantation of *Casuarina*. Settlements are both west and north of the beach, but there is good nesting habitat. Like the previous beach, there was no evidence of nesting.

Dongshan–Six beaches were reported to have had nesting on this island; four were visited. In the north east, Nanmen and Yulan, two contiguious beaches here considered as one, are near to the township. Nanmen actually forms the seaward limit of much of the town; breakwaters and other constructions line the beach. At its south end, free from human habitations, the intertidal zone ends abruptly at actively eroding cliffs of sand and soil. Extensive and prolonged sand mining has evidently been done on this beach, and whatever value it once may have had as a nesting habitat has long since been destroyed. Yulan, which extends to the south, has a few dwellings. Sand is being mined in the north, creating vast depressions and beginning an irreversible erosional process. Other activities

on the beach include rope making, and the omnipresent *Casuarina* plantation lines the beach. At the southern end the beach is relatively undisturbed, and a vegetated beach platform provides good nesting habitat. However, the base of the littoral zone has numerous large rocks, obstructing the approach to this part of the beach. All things considered, there seems to be little significant nesting habitat left here. There was no sign of nesting.

Luoshanxu beach, near Huidong village in the east centre of Dong shan, was reported to have had turtles nesting on it as recent as 1981 or 1982. A narrow platform, vegetated with half a dozen typical strand species, is all that is left of the original coastal habitat, for *Casuarina* has been planted along the beach and cultivation taken to the edge of the *Casuarina*. A vestigeal hedge of *Pandanus* indicates that this beach once had an "oceanic" type strandline vegetation, and that the nesting habitat was once good or excellent. The high beach habitat that remains provides fair nesting habitat.

Guizitou beach is at the southern end of the island, immediately west of Aojiao village. Turtles are said to have nested about 1980. An undulating beach platform has an open *Casuarina* plantation within 10 to 15 m of the HWM. Little remains of the strand vegetation, and there is considerable pedestrian traffic on and along the beach. Although there is fair nesting habitat, there is little chance that a nesting turtle would be able to escape from the beach before being detected and killed.

Houjiang beach is in the extreme south, just east of Gongqian village. Here also it was said that turtles had nested since 1980. The south end of the beach is next to the village and is actively used for fish drying. There is little (if any) natural strand vegetation left. The north end is more isolated, but *Casuarina* have been planted to within 20 m of the HWM. A few strand species occur, and there is a strip with good nesting habitat. As before, no signs of nesting were evident.

Guangdong mainland beaches

Huidong – This county was first visited in the midst of a typhoon on 24 June, and then again a month later with normal weather. Haigui Bay, with a sandy beach less than 2 km long, is on the east side of a stubby peninsula about 100 km north east of Hong Kong. A dune ridge about 10 m high runs the length of most of the beach; it is covered by an intact *Pandanus* hedge. As many as 3 terraces occur between the HWM and dune base, the two seaward platforms are without vegetation and together as much as 50 m wide in the north of the beach. The inland, vegetated terrace (ideal for nesting) is about 10 m wide in the north and nearly 30 m wide in the south. There are about a dozen species of conspicuous strand plants.

In 1984 this area was declared a sea turtle conservation area, and at the major points of entry to the beach large signs proclaim that it is a protected area. A

temporary shelter at the center of the dune ridge houses 1 to 4 beach wardens that patrol the beach and record nesting events by turtles. Before its declaration as a reserve, this beach was subject to human predation, and the skeletal remains of half a dozen *C. mydas* are scattered about. On 26 July there were 17 recent nesting pits, at least 13 of which appeared to contain eggs; these spoors were consistent with those of *C. mydas*. Considering the nesting cycles normally exhibited by this species, there had probably been no more than 6 individual turtles nesting on this beach before 25 July. We were told that general reports about the conservation area and the turtles were top security and secret and could not be shown to us; however, Mr. Zheng and Mr. Huang were given access to the relevant reports and they were allowed to extract from them.

Hainan beaches

Qionghai - This county is known for its turtles, but the majority of the animals we saw were imported from the Xisha Islands, indicating that the local breeding population has been decimated. Seven beaches were reputed to have had nesting, and 5 of these were visited. Fentoulin is north of Taimen village. A vast expanse of sand stretches both northeast and south as far as the eye can see. The offshore bay has a shallow sandy bottom that extends out for about 1 km; it serves as an anchorage for fishing vessels and provides protected waters for dozens of dip net fishing stands. At the south end of the beach an erosional cliff as much as 1 m high has encroached into a small coconut plantation; sand mining has evidently been carried out here. A dense forest of *Casuarina* has been planted along nearly all of the beach to within a few metres of the beach crest. Seaward of the *Casuarina* is a zone about 3 to 5 m wide with a low colonizing vegetation consistiog of about half a dozen typical strand species. This narrow vegetated zone provides good nesting habitat, but the amount of human activity in the offshore and onshore areas greatly decreases the chances of any turtles nesting here; there were no signs of nesting.

Xilu beach is on the south side of Taimen village; the sand beach here extends as far as the eye can see, both to north and south. Dense plantations of coconut and *Casuarina* are within 25 m of the HWM. The vegetated beach platform is dominated by spiny grass. Near to the beach are human habitations and considerable pedestrian traffic. There is a vast emergent tide flat at the base of the beach, and this extends about 100 m seaward; this flat is a major impediment to turtles that attempt to ascend the beach, nest and return safely to the sea. The nesting habitat available is fair to poor, and there was no sign of nesting.

Sutan beach is between Taimen and Bo'ao on a stretch of coast that is an uninterrupted sand beach. Rising from the beach crest about 1 to 2 m is a zone about 3 m wide vegetated with typical strand species. At the landward edge a terrace rises and extends inland for at least 10 m; at its seaward edge is an intact

hedge of *Pandanus* that runs for a total distance of several km. The narrow zone between beach crest and terrace provides good nesting habitat. Although it was stated that as recently as 1983 turtles had nested here, there was no evidence of nesting. There is a well established *Casaurina* plantation inland of the *Pandanus* hedge, but otherwise little human traffic or disturbance. The Sutan beach was one of the two places seen during the entire survey that has a significant remanent of natural coastal vegetation along the beach.

Beimen beach is just north of Bo'ao port, seaward of the village. Not only is it close to a center of human activities, but it is the site of a mechanized mining operation that digs up and washes sand for rare metals. The mouth of the Wanquan River is a few hundred metres south, and this river has evidently been depositing large amounts of sand along the coast here, for there are open rolling dunes on the high beach platform that is nearly 100 m wide and sparsely covered by low colonizing species typical of the strand. Apparently a turtle nested here in 1980, but at present there is poor nesting habitat available—notably because of the mining operation. It is not known if the mining activities will proceed northward along the beach of Sutan; if they do, they will destroy the remanent of beach vegetation that is there.

Donghai (formerly Nangang) beach is south of Bo'ao port; it once again is part of a vast uninterrupted stretch of sandy beach. A wide, gently undulating open dune, some 300 m from beach crest to *Casuarina* plantation, has sparse cover of typical strand species and dune colonizers. The seaward edge of the vegetation is dominated by a spiny grass. There is some pedestrian traffic on and near the beach, but there is a large area of good nesting habitat. It was claimed that as late as 1984 turtles had nested here (and been caught and slaughtered). However, no sign of nesting was seen.

Sanya – There are reported to be at least 4 places with turtles nesting; two are on Xidao Island. It was only possible to visit Haiguishi on the south east of the island. This was the shortest beach visited during the entire survey, about 200 m long. An emergent fringing reef lies about 40 m offshore. The littoral and supralittoral beach are littered with wave worn coral rubble, which is being extracted from the north end of the beach. A zone, some 5 m wide that runs about 10 to 15 m from the HWM, has cover provided by nearly a dozen plant species, typical of the strand. The colonizing vegetation is in succession to shrubs and woody forms, which dominate the beach immediately inland of the strand zone. *Pandanus*, and an Asclepiadaceae (*Pleurostelma* ?) dominate the woody hedge. An *Opuntia*, evidently naturalized on the island, is also conspicuous in the hedge, and it is colonizing the zone of strand vegetation. A few old nest pits, the size of *Chelonia mydas* pits, were in the centre of the beach, and we were told that at least one turtle had nested in 1985. This beach was named "Sea Turtle Market" because of the

large number of turtles that nested here; it now appears that the market has been abandoned.

Hainan marine habitats

Qionghai–Only one marine pasture was seen during the survey, that which grows immediately to the south of a sea wall that extends out from Taimen inlet. To landward is a wide emergent tide flat covered with *Halodule* sp. On a substrate of coarse sand, coral rubble and silt, a mixed species pasture extends from a few m south to the sea wall southward for at least 300 m. At low tide it is covered by about 50 cm of water. Clumps of *Enhalus acaroides* are in slightly deeper water that forms small channels or depressions. The flat shallower area has *Thalassia hemprichii*, *Cymodocea* sp., *Halophila* sp., *Halodule* spp. and *Syriogodium isoetifolium*. The last named forms nearly species pure swards some 50 m from the sea wall, and on 14 July 1985 there were numerous flowers. In many tropical seas, pastures of this type provide feeding habitat for *Chelonia mydas*. There were few algae in evidence. The rubble covered depressions had few angiosperms but 3 brown algae were evident, including *Padina* sp. and *Sargasum* sp.

Sanya - South of Sanya city a peninsula extends toward the southwest. A bay on the east side has a "C"-shaped beach that extends for several km; at its southwest end is a fringe reef about 300 m long. Surge channels perforate the platform at the north end. The south end has an emergent reef platform. The platform is widest (nearly 150 m) in the centre, and narrowest (about 15 m) at the north and south ends. At the outer edge of the platform there is an abrupt drop off to 3 to 6 m deep. Scattered to seaward of the edge are numerous granite boulders. The most active scleractinian coral growth is on these boulders and on the edge of the platform; the most conspicuous species belong to the groups: *Acropora* spp., *Pocillopora* spp., meandrines and faviids. *Porites* spp. were not conspicuous. At the south end of the reef platform Alcynarian type soft corals are conspicuous and in localized places these seem to be dominating the hard corals. Few thalloid algae were evident; there was moderate diversity of coral reef fishes. There was a great abundance of crinoids, and the textural diversity of this reef was good. In conclusion, there was fair feeding habitat and good sheltering habitat for *Eretmochelys imbricata*. It is not known to what level of exploitation this reef is subjected; there was evidence of unnatural breakage to some of the branching hard corals, and fishermen and fishing boats were seen here in ones and twos.

On the west side of the same peninsula, facing Sanya harbour, is a protected bay with long gentle "C"-shaped beach. A vast submergent reef flat extends out 300 to 500 m from the shore. It is covered with coral rubble, sand and silt; there is very little live coral. Shrimp burrows with symbiotic gobies are common. At the edge of the reef flat is a slope from about 1 m of water at mid tide to several metres below the surface. Shoreward of the slope are a few live hard corals, but the ma-

jority of these are broken, solitary, unsupported branches (e.g. *Acropora* sp.) that appear to have been washed in from actively growing colonies elsewhere. Slabs and blocks of dead coral are also common near the slope. Large solitary corals (e.g. *Fungia* sp.) are common on the reef flat, but they, like the branching coral pieces and coral blocks, have evidently been washed in from elsewere. At the slope there are growing colonies of table forms of *Acropora*, but there is only about 25% cover by live corals. There are very few algae on either the reef flat or the slope, and there are very few live mollusks evident. In conclusion, this reef appears to have been very heavily mined for coral and shells; there has evidently been repeated breakage and removal of live coral. It is a habitat poor in species diversity, poor in textural diversity and with very little value as feeding or sheltering habitat for marine turtles. Tourists frequent this bay, for it is next to the grounds of a large hotel.

It must be noted that in and around Sanya large amounts of hard coral are sold as souvenirs; these are eagerly purchased by visitors from the Chinese mainland and from overseas. There is no apparent control on, or concern for, the amount of coral destroyed and sold. This is symptomatic of large scale destruction of the near shore marine environment.

INTERVIEWS

There is no substitute for direct examination and investigation of specimens and habitats. However, untrained people during their lives accumulate a wealth of knowledge, and although this is often subjective, mixed with superstitions, and not organized scientifically, the information provides unique and valuable opportunities to make inferences about situations outside the scope of an individual scientist's personal experiences. In the case of sea turtles, the experiences of professional fishermen and people who live along the sea coast provide valuable sources of information. After several days trying different methods at questioning fishermen, we made up a standarized interview form, this was translated into Chinese and duplicated (see Appendix II) (omitted).

Language is a tremendous barrier in China - not only to those who speak no Chinese but also to natives. The diversity of dialects and pronunciations, in a language that depends on subtle differences in tones, makes it difficult — if not impossible—for neighbors to communicate efficiently with each other. When one is trying to extract precise, objective information from people not trained in the scientific method, this further complicates an already difficult situation. It was, thus, not uncommon to have 10-minute discussions to get a two word answer to a specific question. Because each question was asked three times (English - Mandarin - local dialect, and back by the reverse route), the chances of misunderstandings and erroneous or misinterpreted end products were very great. Nonetheless, a major effort was put into interviewing coastal people and fishermen in an effort to learn:

species occurrene, seasonality and abundance; status, past and present; rates of exploitation, past and present; reproductive sites and seasons; and economic value. A total of 59 interviews were conducted, some under makeshift conditions on a beach, but most around a table. In Fujian 32 interviews were recorded, 12 on the Guangdong mainland, and 15 on Hainan Island. The number of common names used for sea turtles in just Fujian and Guangdong provinces is at least 75; of these, 25 can be assigned with certainty to a certain species of sea turtle. The remaining 50 names are used for several species and/or have imprecise definitions so that they are of limited use.

The names that can be individual species are those that refer to the distinctive *Dermochelys coriacea* and the economically important *Eretmochelys imbricata*. Some 13 names apply to the former and 10 to the latter. Six names were related to a large-headed turtle, probably *Caretta caretta*.

There were reports of nesting from Pingtan Island to Hainan Island, but the only place where there was any evidence for recent nesting (and this was very little), and the only place where the species nesting could be identified, was in Huidong, Guangdong province.

With but 1 or 2 exceptions (and these exceptions are of questionable reliability) it was unanimously stated that sea turtles had become much less abundant over the last few decades. It was usual to hear that once sea turtles had been revered, venerated or respected in some way, and that they were released when accidentally caught. However, in recent years most turtles that are caught are killed. Given that a single turtle may sell for the equivalent of a month's wages, this is not hard to understand. It is also relevant that in recent years new markets have appeared in China; nowadays all parts of the turtle can be sold for a handsome profit, whereas formerly certain parts like the shell and bones were useless and thrown away. (It seems that in the last few years the shells of turtles have been bought to make wine!)

Direct exploitation on sea turtles in China is of 3 kinds: capturing animals intentionally at sea with trammel nets, harpoons, and other means; capturing animals specifically on nesting beaches; and capturing animals accidently, or incidental to other fishing activities, in fishing nets, trawls or with other fishing gear not designed to catch turtles. This last phenomenon occurs throughout coastal Fujian and Guangdong, in varying degrees depending on place, season, gear and other variables. At any one place the incidental capture may seem insignificant, but the annual catch of sea turtles in Fujian and Guangdong may approach 1000. Although the absolute number of nesting animals caught on the mainland is surely very small, the percent of nesting animals that are caught must be very high; nesting females were said to be caught in Fujian and Hainan, and formerly they were captured in Huidong — before the creation of a conservation area. The only places today where

sea turtles are purposefully caught at sea are Hainan and Xisha Islands. It is likely that nesting turtles are caught in large numbers in Xisha. The majority of sea turtle specimens that were seen during the present survey were *Chelonia mydas* in Wenchang and Qionghai Counties, Hainan Island; the vast majority of these were said to have come from the Xisha Islands. Given the enormous amounts of coral, giant clams (*Tridacna* sp.), sea snails (*Strombus* sp. etc.) that are also mined from the Xisha Islands, it is clear that there is rampant, unchecked exploitation of *potentially* renewable natural resources in the Xisha Islands.

Only 3 people had any knowledge of tags on sea turtles, but it was impossible to decipher which species of turtle had been tagged or what the tags had inscribed on them. Several people had knowledge of turtles bearing chinese words engraved on their shells.

CONCLUSIONS

Five species of sea turtles frequent the South and East China Seas; 3 of these have been recorded in scientific writings since the early part of the present century: *Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*. The 2 members of the subfamily Carettinae (*Caretta caretta* and *Lepidochelys olivacea*), as in other parts of the world have been confused and often misidentified as a single species ("*Caretta olivacea*"), combining the characteristics of the two (see Zhou 1983; Frazier 1985b). It is now clear that both *Caretta caretta* and *Lepidochelys olivacea* are relatively common, at least in the East China Sea. *Dermochelys coriacea* is also a regular visitor to the East China Sea, although captured less often. *Chelonia mydas* is common in the South China Sea, where *Eretmochelys imbricata* is also found most often. Yet, all 5 species occur from Hainan Island to the north of Fujian.

Captures of all 5 species appear to be most common during summer months. *C. caretta* are evidently caught mostly during summer in the south but mostly during the autumn in the north. However, the records are not standardized and are likely to be effected by biases in both fishing and collecting efforts.

The size classes that are caught most often, for all species except *Eretmochelys imbricata*, are subadults and adults. Immatures of *C. mydas* and *E. imbricata* are caught with notable frequency.

There are indications of ontogenetic variation in several body proportions, because of allometric growth, and this point needs to be investigated in more detail. Although there are some sexually related differences in several morphometric variables and proportions, the data are too few to describe the differences statistically. The meristics of Chinese sea turtles are consistent with those of other populations for the respective species.

Although there may be some small regional differences, on the whole other

external characterisitcs, e.g., scalation and coloration, are also comparable to those of other populations of the respective species. Even epizoa and rates of colonization conform to the general situation—except, however, the occurrence of heavy infestations of *Stomatolepas* sp., and resultant disease—like conditions.

One of the most important biological questions to be answered is "From whence come the Chinese sea turtles? " *Chelonia* reproduces in China, but there is no verified record of reproduction by other species. Nesting by *Dermochelys* is most unlikely. It is possible that the remaining species nest in China, but most unlikely that there are large Chinese breeding populations still to be discovered.

There is potentially good nesting habitat on isolated beaches from southern Fujian to Hainan Island. Although turtles are said to have once nested from Pingtan to Hainan, the number of animals now nesting annually on this coast of nearly 4000 km in length, is very few (possibly a dozen or two), and mainly (if not entirely) *Chelonia*. The annual number of *Chelonia* nesting in the Xisha Islands is evidently large, but no detailed studies have been done.

Except for *Chelonia*, which evidently breeds in fair numbers on the oceanic Xisha Islands, any reproduction which occurs in China is unlikely to produce a significant part of the populations found in Chinese waters. This was probably not true before the impact of Man was as great as it is now, and nesting by other cheloniid turtles may have once been widespread.

Despite a lack of quantified information, there can be little doubt that the populations of Chinese sea turtles have undergone major declines; this is the opinion of virtually every fisherman and fisheries official interviewed, and this is, sadly enough, consistent with the general pattern around the world.

Several factors are likely to be related to (if not the main cause of) the decrease of Chinese sea turtles. The exponential increase in human populations and their technology is at the base of the problem. Direct exploitation of sea turtles has increased from several factors; greater numbers of people fishing; motorized vessels and gear that enables fishermen to travel farther and faster; modern net fibers (nylon and monofilament) that have greater catch efficiencies than natural fibers; modern techniques such as trawling and purse seining that effectively entrap organisms in vast volumes of water, capturing many non-target species; and also contemporary attitudes that now generally accept complete utilization of sea turtles in a profit-based economy (rather than the old traditional custom of respecting the live turtles and releasing them for religious reasons).

Coupled with this is massive habitat degradation. Many beaches, as well as coastal areas, have been destroyed by uncontrolled sand mining and resultant erosion. After-the-fact checks, to control this erosion (*viz* sea walls) are rare, but these constructions completely destroy the high littoral and supralittoral beach habitat, as well as the dynamic nature of sand movement. Vegetation modification

by cutting natural strand plants as well as by developing plantations of *Casuarina* and coconut down to the strand line greatly reduce the area and quality of nesting habitats. Human habitation on, or near to, beaches, and the resulting activities and disturbance are likely to drive away breeding turtles (if they are not first caught and killed). Of the entire coast of Fujian and Guangdong, which totals nearly 4000km, there are only a few km of coast that are reserved and protected; less than 2km in Huidong county and probably less than 2km in Sanya county. Virtually the entire coast has been modified in some form or another.

The situation in the Xisha Islands is alarming to say the very least. It appears that there is not only no control of exploitation of marine resources, but intense exploitation of resources which are potentially renewable. These natural resources will soon be squandered if the overexploitation continues.

RECOMMENDATIONS

There is an urgent need to gather basic information in a quantitative and standardized way. Particularly valuable will be fisheries statistics, e.g., dates, localities, conditions of environment, capture techniques, species, weight, length and sex. Information on tagged turtles is desperately needed; data as above in addition to tag type, number and address.

Every effort should be made to reduce the incidental capture of sea turtles—particularly in breeding areas. Trawl efficiency devices (= TED = turtle excluder device) should be tested by Chinese fishermen, modified if necessary, and installed on all trawls. Fishing near breeding areas should be prohibited during the breeding seasons.

Detailed, *non intrusive*, studies on nesting beaches should be initiated on a long term basis with trained personnel, incorporating postgraduate students that can make a long term commitment for research purposes. The design of these studies should be developed on the basis of progress made in programs in other regions that have been going on for 30 years; there is no reason to repeat the mistakes made many years ago. These studies should include nest habitat ecology, reproductive ecology, and intense tagging.

In Xisha Islands all of the above approaches are needed. It is ironic that Xisha Islands seems to be the most important area in China for marine turtles, yet it is the area that has been least studied and is subjected to the highest level of exploitation.

The agencies best situated for this work, and the agencies with responsibility to manage and protect the sea turtle resources, are the Aquatic Products Bureaux. It is of the greatest importance that personnel in the Aquatic Products Bureaux be informed about the sea turtle situation and how best to solve the conservation pro-

blem. Cooperation and communication between counties and provinces is also of the highest priority. Full cooperation and collaboration with academic and research professionals is just as important; in this way the greatest benefits will be derived from different professionals with different specialities.

The present survey, as those that have gone before it, represents a small but significant beginning. A great deal of basic information still needs to be documented and recorded quantitatively; basic conservation problems need to be solved with some urgency; critical habitats must be given the fullest protection—ideally as reserves; fundamental descriptions of the status of the populations and their habitats need to be distributed and explained to policy makers; nationally important laws made by the central government need to be enforced in the various counties where they are now being ignored.

Yet, the results of this survey show that China has a great diversity of turtle species, some of which occur in considerable abundance. There is a great eagerness for different agencies to collaborate, including management, academic and research organizations; this cooperation has also transcended geographic boundaries between 17 counties, 2 provinces and 2 nations. All the signs are that successful programmes are being developed by counties, provinces and the central government. With the present rate of advance the future for sea turtle conservation and research in China bodes well.

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The survey would not have been possible without the generous assistance of a great many people and organisations. Political and academic leaders in the Fujian Province Government, Fujian Teachers University, and Department of Biology gave generous support. Local political officials and other authorities, notably leaders and staff of the Aquatic Products Bureaux, provided valuable assistance in: Pingtan, Shishi, Zhangzhou, Zhangpu, Dongsha, (Fujian), Shantou, Haifeng, Huidong, Guangzhou, Yangjiang, Zhanjiang, Haikang, Xuwen, Haikou, Wenchang, Qionghai, and Sanya (Guangdong). Various museums assisted with specimens: Fujian Teachers University (Mr. Zheng Ji), Fujian Provincial Museum (Mr. Lee Shuqing), Dongshan 2nd Middle School (Mr. Au Yingmou), South China Sea Institute of Oceanology (Dr. Chen Zhenran), and Zhong Shan University (Dr. Lin Haoren). Countless fishermen in coastal Fujian and Guangdong gave generously of their time and knowledge. Invaluable assistance with translations was given by Fan Yen, Liu Zhendeng, Zhao Jianzhong, Chen Huanan, Zheng Zhiping, Chen Guoming, Wen Jianghua, Zhu Zhiwen, Yin Dahu, Wang Mu, Xiu Xiu, Yang Qinlan, Xu Xiu, Lin Qiuping, Lin Xinyun, and many others. Generous support was also provided by Mr. John Lundin, USIS, Guangdong. Funding for the study was provided by the

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APPENDIX I. ABBREVIATIONS

Measurements:

Curved carapace length	=CCL
Curved carapace width	=CCW
Head width	=HW
Plastron length	=PL

Museums:

Dongshan 2nd Middle School	=DSMS
Fujian Provincial Museum	=FPM
Fujian Teachers University	=FTU
South China Sea Insitute of Oceanology	=SCSI
Zhongshan University	=ZSU

CAPTIONS TO FIGURES

Figure 1. Size frequency histogram for curved carapace length in *Caretta caretta*.

Figure 2. Relationship between log curved carapace width and log curved carapace length in *Caretta caretta*.

Figure 3. Relationship between log head width and log curved carapace length in *Caretta caretta*.

Figure 4. Relationship between log plastron length and log curved carapace length in *Caretta caretta*.

Figure 5. Size frequency histogram for curved carapace length in *Lepidochelys olivacea*.

Figure 6. Relationship between log curved carapace width and log curved carapace length in *Lepidochelys olivacea*.

Figure 7. Relationship between log head width and log curved carapace length in *Lepidochelys olivacea*.

Figure 8. Relationship between log plastron length and log curved carapace length in *Lepidochelys olivacea*.

Figure 9. Size frequency histogram for curved carapace length in *Chelonia mydas*.

Figure 10. Relationship between log curved carapace width and log curved carapace length in *Chelonia mydas*.

Figure 11. Relationship between log head width and log curved carapace length in *Chelonia mydas*.

Figure 12. Relationship between log plastron length and log curved carapace length in *Chelonia mydas*.

Figure 13. Size frequency histogram for curved carapace length in *Eretmochelys imbricata*.

Figure 14. Relationship between log curved carapace width and log curved carapace length in *Eretmochelys imbricata*.

Figure 15. Relationship between log head width and log curved carapace length in *Eretmochelys imbricata*.

Figure 16. Relationship between log plastron length and log curved carapace length in *Eretmochelys imbricata*.

Figure 17. Size frequency histogram for curved carapace length in *Dermochelys coriacea*.

Figure 18. Relationship between log curved carapace width and log curved carapace length in *Dermochelys coriacea*.

Figure 19. Relationship between log head width and log curved carapace length in *Dermochelys coriacea*.

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Atoa Herpetologica Sinica

乌梢蛇属(蛇亚目：游蛇科)头部的形态学研究

V。乌梢蛇属、鼠蛇属、锦蛇属和翠青蛇属头部形态的比较研究及其机能和演化初探

张 服 基
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在我国蛇类的形态和分类研究方面，过去多注重外部形态的描述，如鳞被、体形、色斑及上颌齿等。现国外无论在科间关系讨论(Dowling，1959；Johnson，1955；Marx等，1972)，还是在属种分类及系统关系研究中一般多择重于解剖特征——尤其头骨特征的研究(Bogert，1947；Maglio，1970；Rossman等，1977；Cundall，1981；Campbell等，1982；Voris，1977)。近年来，对蛇类比较解剖学的深入研究以及有关机能形态和演化研究方面，则多择重于头部形态结构的研究(Albright等，1959；Kardong，1974，1977)。

作者曾对中国产游蛇亚科的半阴茎形态特征进行了比较，并初步探讨了它们之间的系统演化关系，认为乌梢蛇属、鼠蛇属、锦蛇属和翠青蛇属等的关系较近(张服基等，1984)。本文详细比较了这些属种间头部形态特征，并初步讨论了它们的类型、演化及机能。

共解剖10种，分隶4属。

乌梢蛇*Zaocys dhumnades* (Cantor) 5♂2♀

黑线乌梢蛇*Z. nigromarginatus*(Blyth) 4♂1♀

滑鼠蛇*Ptyas mucosus* (Linnaeus) 2号头部标本、1号头骨

灰鼠蛇*P. korros* (Schlegel) 2号头部标本

黑眉锦蛇*Elaphe taeniura* Cope 3♂2♀

紫灰锦蛇*E. porphyracea porphyracea* (Cantor) 1♂1♀

玉斑锦蛇*E. mandarina* (Cantor) 2♂1♀

红点锦蛇*E. rufodorsata*(Cantor) 1♂2♀

三索锦蛇*E. radiata* (Schelegel) 1号头部标本

翠青蛇*Entechinus doriae* (Boulenger) 2♂1♀

头骨形态的比较

乌梢蛇属、鼠蛇属、锦蛇属及翠青蛇属的头骨结构均属于典型游蛇科样式，其基本构造、形状及各部大小比例均存在较多的一致性。但在属间，甚至某些种间，也存在不同

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程度的差异。根据作者对乌梢蛇属头骨的划分，现按下列五个部分分别比较如下（张服基，1987）。

1. 颅腔部分(cranial component)

这部分的主要差异表现在顶骨和前额骨上，其次在额骨、基蝶骨和基枕骨。其他骨片的差异不太明显。

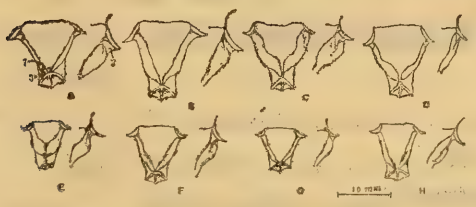

Fig. 1 The shapes of ridges and the bilateral transverse processes in the parietal bone

A. *Zaocys dhumnades*
B. *Ptyas mucosus*
C. *Elaphe taeniura*
D. *E. radiata*
E. *E. p. porphyracea*
F. *E. mandarina*
G. *E. rufodorsata*
H. *Entechinus major*
1. the ridge of the parietal 2. the transverse process of the parietal 3. the ridge of the supraoccipital

1.1 顶骨的差异（图1）

主要是顶骨背面骨嵴的形状。乌梢蛇属两个种的这一骨嵴形态相似，即两侧嵴从近后额骨处向后方延伸，在顶骨后端中央与位于上枕骨背面的“个”形嵴会合，其会合处较宽。鼠蛇属的这一特征接近乌梢蛇属，其不同处是两侧骨嵴在不达顶骨后端时即会合成一较短而窄的嵴，因此两侧骨嵴间夹角较小，其上枕骨上的“个”形嵴也较深而陡。此外，乌梢蛇属顶骨前端两侧向外的横突一直延伸到腹面，因此与其外侧方的后额骨间形成的肌肉附着面较大，且较向腹方倾斜。鼠蛇属的这对横突状态近乌梢蛇属，但其腹缘向背方稍凹进（图1）。

锦蛇属顶骨骨嵴形态的种间差异较明显（图1）。除黑眉锦蛇和三索锦蛇外，其余种类的骨嵴一般较浅。黑眉锦蛇和三索锦蛇的两侧骨嵴在顶骨的后半部分即逐渐会合成一窄嵴；而上枕骨的“个”形嵴亦较深而陡，两侧骨嵴间夹角也比前两属的小（近90°）。紫灰锦蛇骨嵴形状近黑眉锦蛇，只是骨嵴较浅，顶骨的后缘未达上枕骨“个”处(图1)。玉斑锦蛇和红点锦蛇顶骨嵴似乌梢蛇属。此外，除红点锦蛇顶骨前侧的横突向腹方延伸较多（近鼠蛇属状态）外，其余种类的这对横突均较浅且向头后方倾斜，尤其以黑眉锦蛇、三索锦蛇和紫灰锦蛇最明显。

翠青蛇属顶骨特征近乌梢蛇属和鼠蛇属，其前侧的横突向腹方延伸一般。与Cundall (1981)描述基本一致，只是其嵴较浅。

Fig. 2 The lateral process in the prefrontal bone A-H as same as Fig.1

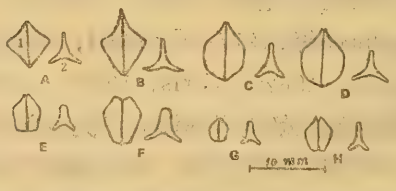

Fig. 3 The nasal bone and the ascending process of the premaxillae A-H as same as Fig. 1
1. the dorsal view of the nasal
2. the anterior view of the premaxilla

1.2 前额骨侧突（图2）

前额骨差异主要在其外侧的突起。乌梢蛇属的这一侧突最窄，侧面观呈长条形。鼠蛇属侧突稍向前延伸，侧面观近三角形。锦蛇属存在二种状态：黑眉锦蛇、三索锦蛇和紫灰锦蛇侧突向前方延伸最多，而玉斑锦蛇和红点锦蛇的延伸较少，尤其红点锦蛇的状态近乌梢蛇属。翠青蛇属状态近玉斑锦蛇。

除上述外，乌梢蛇属因眼径大，因此额

Fig. 4 The palato-maxillary component
A-H the same as Fig. 1
1. the palatine 2. the pterygoid 3. the maxilla 4. the ectopterygoid 5. the medial process 6. the maxillary process 7. the palatine process 8. the ectopterygoid process 9. the medial process of the ectopterygoid 10. the lateral process of the ectopterygoid 11. the ectopterygoid process extending posteriorly and the elongate lateral process of the ectopterygoid in *E. major*

骨于眼眶部位内陷较深，鼠蛇属的状态亦类似。其余种类的额骨内陷均不太深。此外，鼠蛇属和乌梢蛇属基枕骨腹面的骨嵴突起也较一般明显。

2. 鼻腔部分(nasal component)

这部分的差异主要在鼻骨，其次是前额骨。

2.1 鼻骨的差异（图3）

鼻骨背面部分的形状于各属种间存在不同程度差异。锦蛇属的鼻骨一般较大，呈梯形、刀形等。翠青蛇属与锦蛇属近似，呈刀形。鼠蛇属鼻骨略变小，呈长三角形。乌梢蛇属最小，三角形。

2.2 前颌骨的升突（图3）

乌梢蛇属和鼠蛇属的前额骨升突成长锥形。锦蛇属的这一升突较宽，呈长条形，尤其玉斑锦蛇的最宽。翠青蛇属近似锦蛇属的状态。

3. 腭上颌部分（palato-maxillary component）

这部分的差异主要是上颌骨的形状和各骨间关节突的形状（图4）。

3.1 上颌骨及其突起

在锦蛇属中，上颌骨一般较细而长，其后端一般都超过后额骨的后缘，尤其黑眉锦蛇和三索锦蛇等最为明显；上颌齿12-24枚；红点锦蛇、三索锦蛇和玉斑锦蛇的后端上颌齿略粗大。乌梢蛇属上颌骨的后端仅达后额骨后缘处，因此较短而宽；上颌齿20-25枚，最后3-4枚粗大。鼠蛇属与乌梢蛇属类似。翠青蛇属上颌骨较细，其后端略过后额骨后缘；齿数约20。

乌梢蛇属上颌骨的腭突(palatine process) 较宽大，呈梯形；其外翼骨突 (ectopterygoid process)不大且较窄，呈梯形或近三角形，位于外翼骨前端分叉的凹部。鼠蛇属的突起状况似乌梢蛇属。锦蛇属中，腭突一般均较窄，尤以黑眉锦蛇明显；其外翼突一般较宽且较向上颌骨后端延伸，因此突起

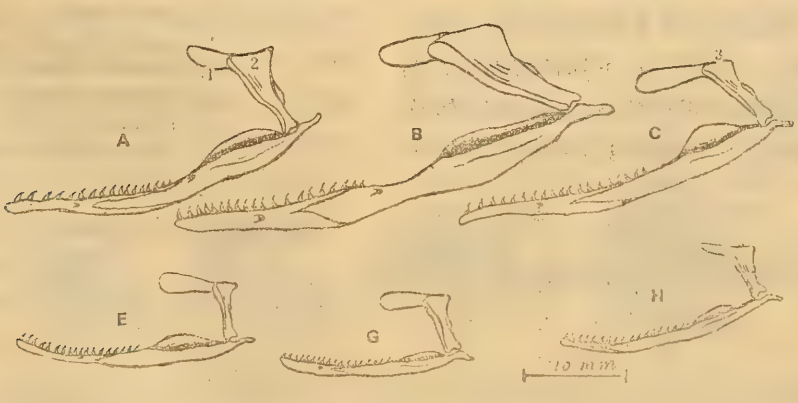

Fig. 5 The mandibular component
A-H the same as in Fig. 1
1. the squamosal 2. the broad squamo-quadrate articulation 3. the narrow squamo-quadrate articulation

的后部被外翼骨所复盖。翠青蛇属腭突亦较宽大，似乌梢蛇属；但其外翼突与其他种类均不同，明显向斜后方延伸很多，近长方形，后部为外翼骨复盖较多(图4)。

3.2 腭骨内突

乌梢蛇属和鼠蛇属腭骨的内突 (medial process，也叫choanal process)较宽大，呈梯形。锦蛇属内突一般略变窄，近三角形。翠青蛇属的内突已很退化，仅呈一浅突起。

3.3 外翼骨形状

翠青蛇属的外翼骨形状独特，前端分叉的外支相当延长，远远大于其内支 (spatulate process)，与Cundall (1981)描述同。其余属种的外翼骨形状相似，外支宽，内支窄。锦蛇属中内支略变小 (图4)。

4. 下颌部分(mandibular component)

差异主要在方骨及其与鳞骨关节形式，其次在下颌凹窝 (fossa) 的内壁突起状况(图5)。

鼠蛇属和乌梢蛇属方骨的近端明显宽大，关节于鳞骨的后半部，占鳞骨总长的1/2或以上；它们的下颌凹窝内壁突起不大。翠青蛇属的状况与乌梢蛇属相似，但其鳞骨较小。锦蛇属的方骨近端变窄，因此两端宽度相近，呈长条形；其关节占鳞骨长的2/5以下；但下颌凹窝内壁的突起较大。

5. 舌器部分(hyoid component)

舌器 (apparatus hyoideus) 的形状在游蛇科中相似。其差异在于其长短大小。乌梢蛇属和鼠蛇属的舌弓从第1-2腹鳞延伸到第18-20腹鳞处。翠青蛇属舌弓也达第19-20腹鳞处。锦蛇属一般达第13-15腹鳞处，仅发现红点锦蛇有的标本达第18腹鳞处。

头部肌肉的比较

从比较解剖可见，这些属种头部肌肉的基本结构大体一致。由于肌肉的解剖比较比起骨骼来较为困难，因此向来为比较解剖和分类讨论时忽略。其实肌肉的形态结构在不同属种间也存在不同程度差异，并与头骨的结构和活动状况有一定关系。在此仅就其主要差异的情况分述如下。

1. 下颌收肌系(adductores mandibulae)

这些属种的下颌收肌均包括3对外收肌、1对中收肌、2对内收肌和1对深收肌。这些肌肉的差异不大，主要在肌纤维的走向及其着力方式上，这从前外收肌的比较清楚可见(图6)。

乌梢蛇属的前外收肌起于后额骨后方的

Fig. 8 The cephalic glands of *Z. dhumnades*

1. premaxillary gland
2. nasal gland
3. supralabial gland
4. infralabial gland
5. Harderian gland
6. Duvernoy's gland
7. anterior temporal gland

Fig. 6 The adductores mandibulae

A. *Zaocys dhumnades*
B. *Elaphe taeniura*
C. *E. mandarina*
D. *Entechinus major*
1-2 m. adductor mandibulae, pars anterior

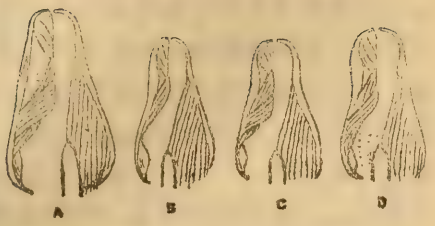

Fig. 7 The intermandibular muscles
A-D the same as in Fig. 6
1. m. intermandibularis anterior
2. m. intermandibularis posterior, pars anterior 3. m. intermandibularis, pars posterior 4. m. neurocosto-mandibularis

顶骨背侧骨嵴处，肌纤维斜向后下方，绕过口后角，大部分纤维止于下颌凹窝前方，因此外观呈一弧形，与下颌间夹角较大（闭口时），其着力方向几乎垂直于下颌。鼠蛇属和翠青蛇属的前外收肌状态与乌梢蛇属的相似。在锦蛇属中存在两种不太相同的状态：黑眉锦蛇、三索锦蛇和紫灰锦蛇的前外收肌起点面较宽，起于后额骨后缘及其后方的顶骨嵴处，肌纤维比较平缓地斜向后下方，与下颌间夹角较小，这与前述的顶骨两侧横突的特征是一致的；玉斑锦蛇和红点锦蛇的状态较接近于乌梢蛇属。

其他下颌收肌的差异不明显。

2. 下颌间肌 (musculi intermandibularis)

乌梢蛇属的下颌间前肌比较粗大，明显成3束；下颌间后肌有2对，即后下颌间后肌（也叫后下颌间肌后部）虽然薄，但明显存在。鼠蛇属和翠青蛇属也与此类似。锦蛇属的下颌间前肌一般较窄，尤其以黑眉锦蛇最明显；它们的下颌间后肌后部大多已退化不可见，仅在玉斑锦蛇中见其痕迹（图7）。

3. 颈缩肌(m. constrictor colli)

这一肌肉明显存在于乌梢蛇属、鼠蛇属和翠青蛇属中。此肌位于后下颌间后肌的后方，较薄，紧贴颈部皮肤下方。锦蛇属中，仅见红点锦蛇和玉斑锦蛇中此肌明显可见，而其他种中均较退化，尤其黑眉锦蛇中几乎不可见。

此外，与颈部皮肤收缩有关的颈方骨肌在锦蛇属中也比乌梢蛇属中的细小。

4. 舌骨舌肌(m. hyoglossus)

相比，此肌在乌梢蛇属中较长而粗，起于角舌软骨的后端（第18-20腹鳞），于第7-10腹鳞处插入舌肌。鼠蛇属和翠青蛇属也大致如此，仅翠青蛇属的这一肌肉较细。锦蛇属的舌骨舌肌一般较细小，从第3-7腹鳞到第13-15腹鳞处。

头部皮肤腺的比较

这四个属的头部皮肤腺一般包括前上颌腺、鼻腺、上唇腺、下唇腺、舌下腺、侧舌下腺、前颞腺以及Harderian腺和Duvernoy's腺。除前颞腺很小，不易观察外，其余腺体在位置及形状上一般较为一致，易进行比较。

乌梢蛇属和鼠蛇属的上下唇腺较一般种类的粗大，而锦蛇属的较细而窄。差异较大的是Duvernoy's腺（图8）。乌梢蛇属和鼠蛇属的这一腺体存在于Harderian腺腹下方的上唇腺背缘。翠青蛇属未发现此腺体。锦蛇属有两种情况：红点锦蛇、三索锦蛇和玉斑锦蛇中该腺体存在，但其大小有不同，而黑眉锦蛇和紫灰锦蛇中则无。Duvernoy's腺的有无或发达程度可能与上颌齿的状态有某种联系，因乌梢蛇属和鼠蛇属的最后3-4枚上颌齿明显较粗大，红点锦蛇、三索锦蛇和玉斑锦蛇的后端上颌齿也比其余齿略大，而无Duvernoy's腺的蛇类一般未发现此特征。这种状况的意义有必要进行研究。

头部形态的类型分类和演化意义

通过解剖比较可见，蛇类头部的形态特征在不同的属种间一般较稳定，其状态在分类和系统演化研究上很有意义。以往机能形

态的研究较注意头部肌肉的结构特点，对其分类学意义亦讨论不多。国内这方面的研究还很薄弱，因此这一工作的深入进行是有一定意义的。

从前述已可见，中国产乌梢蛇属和鼠蛇属的属内特征较为一致，变异不大，但锦蛇属的属内种间差异则较大，由此可见锦蛇属内已出现较大的分化。

作者曾依据半阴茎形态的比较研究认为在游蛇科蛇类中这几个属的系统关系最近（张服基等，1984）。本文从其头部形态结构存在较多的共同特征，也证实了这一观点。

现把这四个属的头部形态结构归纳成以下几个类型。

1. 乌梢蛇属和鼠蛇属

上颌骨均较宽而短，后端仅达后额骨的后缘，最后3-4枚上颌齿最粗大，其腭突较大呈梯形，而外翼突较窄小；外翼骨前端的内支窄小；腭骨的内突呈梯形；方骨近端宽大，关节面占鳞骨长的1/2或以上；下颌凹内壁突起不大；鼻骨小，近三角形；前颌骨升突呈锥形；顶骨两侧嵴于其后端或近处相会成三角形；前额骨侧突较窄；眼较大，乌梢蛇属眼径/眼到吻长为97-110%，鼠蛇属为80-90%；闭口时前外收肌与下颌间夹角较大，近于垂直；下颌间肌和颈缩肌较发达，有二对下颌间后肌；有Duvernoy's腺。

2. 翠青蛇属

上颌骨的外翼突延伸成长方形；外翼骨外支远比内支长；腭骨内突退化，比一般浅得多；顶骨嵴、方骨及下颌凹等特征近乌梢蛇属，而上颌骨、前颌骨和鼻骨形状近似锦蛇属；前下颌收肌、下颌间肌和颈缩肌的状态接近乌梢蛇属，但舌骨舌肌细小；无Duvernoy's腺。

3. 黑眉锦蛇、三索锦蛇和紫灰锦蛇

顶骨嵴于顶骨后半部会合成一较长而窄的嵴；除紫灰锦蛇外，上枕骨"个"嵴较深且陡；顶骨前侧横突向腹面延伸不多，但较向后下方延伸；前额骨侧突向前延伸且较大；鼻骨一般较大，呈梯形；前颌骨升突较宽，长条形；上颌骨较细而长，超过后额骨后缘，其腭突较窄，外翼突较宽；腭骨内突亦较窄；其方骨近长条形，关节面仅占鳞骨长的2/5以下；下颌凹的内壁突起较大；舌弓较细而短；前外收肌与下颌间夹角小；下颌间前肌较窄，后下颌间后肌无；颈缩肌退化；颈方骨肌较细小；舌骨舌肌也细小。

4. 玉斑锦蛇和红点锦蛇

这两个种间也明显存在一定的差异，尤其红点锦蛇与其他锦蛇类差别较大，把它们放在一起讨论，仅是为了便于归纳而已，看来有必要进一步作分类研究。

它们的顶骨嵴形状、前外收肌与下颌间夹角及颈缩肌状态均类似乌梢蛇属，但其骨嵴均较浅，其他特征多与黑眉锦蛇接近。红点锦蛇的前额骨侧突状态近乌梢蛇属，有Duvernoy's腺。

最后，我们可初步推断：在这些近缘属中，以黑眉锦蛇为代表的部分锦蛇属种类可能代表了它们中的较原始类群，而乌梢蛇属可能是较进化类群，鼠蛇属与乌梢蛇属关系较近，翠青蛇属可能是较早从原始主干分化出来的一个分支。

结构与机能间关系的初步分析

任何结构及其变异均与机能及其适应相联系。蛇类头部形态特点显然与其特殊的运动和吞噬方式有较密切的关系。蛇的吞噬活动是一个复杂的过程，但有两个主要的特点：一是上下颌间极度地张开；二是两下颌间极度地扩张，且可独立地交错运动，其腭上颌弓也可配合两下颌运动向左右扩张和独

立交错运动。不同蛇类由于食性、摄食及吞噬方式的差异，必然在其结构上也会产生一定的适应性变化。已知这些种类的食谱一般是鼠类、鸟类、蜥蜴及蛙类，仅翠青蛇主要以蚯蚓和昆虫的幼虫为食，除已知红点锦蛇为半水生性外，一般已知均为陆生性蛇类。但在相近蛇类间由于其主要食物及其吞噬方式上的不同也会在其结构上带来一定的差异。现以乌梢蛇和黑眉锦蛇为代表试分析如下。

从上述可见，乌梢蛇和黑眉锦蛇分别是两个不同类群的代表。从野外观察可见，乌梢蛇喜食蛙类及小鱼和蜥蜴类，多生活于丘陵山坡、平原等地，比黑眉锦蛇更接近水边；黑眉锦蛇比之乌梢蛇更喜食鼠类，因此常栖于房屋及其附近，甚至侵入人的居室内。

由于下颌弓的联结形式可决定上下颌间的垂直扩张程度，因此先比较这两类蛇的下颌弓联结的差异。如前所述，黑眉锦蛇的方骨窄长，关节于鳞骨的最后端且面较小，而乌梢蛇的方骨较宽大，其关节面占了鳞骨的后1/2，因此可以推测黑眉锦蛇的这种联结方式使其下颌弓具有更大的垂直扩张能力。此外，黑眉锦蛇顶骨两侧的横突方向明显较向头后方延伸，因此其坡度较平缓，使位于其背后方的前外收肌亦向后延伸较平缓，而其前外收肌止点位置与乌梢蛇同，均在下颌凹的前方，因此当闭口时与下颌间的夹角较小，这一特征也会增加黑眉锦蛇下颌的垂直扩张能力。顶骨嵴、头侧面、方骨前缘及整个下颌凹的内外壁均为收肌群附着处，收肌的主要作用在于闭口。显然顶骨嵴和下颌凹形状对收肌的作用能力有一定影响。黑眉锦蛇顶骨嵴的后半部较靠头的顶部，此嵴与其后方枕骨的"个"嵴均较深，这增加了中外收肌的附着面，同样黑眉锦蛇比乌梢蛇突起较大的下颌凹内壁也相应增加了中外收肌和中收肌的附着面积，这一形式使黑眉锦蛇口在极度张开时具有更强的回收下颌能力。同时，黑眉锦蛇整个收肌群作用力的方向较乌梢蛇更靠后方。由此可见，黑眉锦蛇下颌与头骨间的联结形式使其下颌弓比乌梢蛇具有更大的垂直扩张能力。

相反，黑眉锦蛇的下颌间肌群、颈缩肌和颈方骨肌均不如乌梢蛇发达。由于这些肌肉的收缩一般与两下颌的左右扩张及颈部皮肤的收缩能力有关，因此可以看出黑眉锦蛇下颌的水平扩张能力和颈部收缩能力不如乌梢蛇。乌梢蛇的吻部呈圆弧形，较黑眉锦蛇略宽，左右两上颌或两下颌间排列较为平行，这一形式亦有利于上下颌的水平扩张和收缩。此外。在黑眉锦蛇的腭上颌弓中，除后端的外翼突较大外，其余彼此关联的突起明显较乌梢蛇窄小，这可能也是由于其上下颌的水平扩张和活动能力不大，因而这些突起较为退化的缘故。此外，从解剖可见黑眉锦蛇鼻吻部骨骼与皮肤间联系紧密，其鼻骨和前额骨侧突较大且与额骨、鼻骨联系紧密，亦不如乌梢蛇该部联系松弛。乌梢蛇的鼻骨和前额骨侧突均较退化，因此彼此间联系及与皮肤间联系均较松弛。据此可推测乌梢蛇在吞噬过程中其鼻吻部具有相对大的上下左右活动余地，这也可能补充其口腔在垂直面上的活动能力。由此可见，乌梢蛇上下颌的水平扩张能力及其颈部扩张能力较黑眉锦蛇类为大。

从上述可知，在亲缘关系较近的蛇类间，其头部形态结构和机能与其食性和生活习性有一定关系。在吞噬过程中，它们口腔容积的增加由两种方式决定，一是上下颌间的垂直扩张能力，二是两上颌与两下颌间的水平扩张能力及颈部扩张能力。由于主要食性的差异也会带来不同蛇类吞噬方式的差异，甚至在结构上的差异。

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STUDIES ON THE CRANIAL MORPHOLOGY OF *Zaocys* (SERPENTES:COLUBRIDAE) V. A COMPARATIVE STUDY ON THE CRANIAL MORPHOLOGY OF CHINESE *Zaocys*, *Ptyas*, *Elaphe* AND *Entechinus*, WITH PRELIMINARY DISCUSSIONS ON THE FUNCTION AND PHYLOGENY

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Abstract

The cranial structures of 10 species of Chinese snakes, *Zaocys dhumnades*, *Z. nigromarginatus*, *Ptyas mucosus*, *P. korros*, *Elaphe taeniura*, *E. porphyracea porphyracea*, *E. mandarina*, *E. rufodosata*, *E. radiata*, and *Entechinus doriae*, in 4 genera (Colubrinae) are morphologically compared through anatomy.

The characters of their skulls, head muscles, and cephalic glands are discussed. The skulls of all 10 species examined display a generalized colubrid pattern and are essentially similar, though some intergeneric and even interspecific differences

may be observed (Figs. 1-5). These species are different in the shapes of the parietal ridge, the lateral process of the prefrontal, the nasal, the ascending process of the premaxillae, the quadrate, and the articular processes of the palato-maxillary arch, the size of orbit, the pattern of squamo-quadrate articulation, and the length of the hyoid apparatus. The main differences in muscles consist in the adductors mandibulae and the intermandibular muscles (Figs. 6-7). The direction of muscle fibers and the pattern of function of the adductors mandibulae are different. For example, when the mouths of *Zaocys* and a few other snakes are closed, the angle between the mandible and the pars anterior of m. adductor mandibulae externus is larger than that in *E. taeniura*, *E. radiata*, and *E. p. porphyracea*, and the line of action is almost vertical to the mandible. In *Zaocys* and a few other snakes, the m. intermandibularis anterior is comparatively thick and consists of 3 bunches, while in *Elaphe* this muscle is narrow. The pars posterior of the m. intermandibularis posterior of *Elaphe* is so degenerate that it cannot be determined. Although constrictor colli is generally present in most snakes, it is absent is some *Elaphe* snakes, e. g. *taeniura*, *radiata*, and *E. p. porphyracea*. Besides, the size of m. hyoglossus is also different among these snakes. Among the cephalic glands, Duvernoy's gland presents the most remarkable difference. There is no such gland in *E. taeniura*, *E. p. porphyracea*, and *Entechinus major*, and the size of it is different from species to species in the other snakes observed. It is discovered that the degree of development of this gland is correlated to the degree of development of the posterior maxillary teeth. There are at least 4 types of head structures based on comparison: 1. *Zaocys* and *Ptyas* type; 2. *Eniechinus* type; 3. *E. taeniura*, *E. radiata* and *E. p. porphyracea* type; and 4. *E. mandarina* and *E. rufodorsata*. The relationship of the two snakes of type 4 deserves further study, as considerable differences can be distinguished between them, especially between *E. rufodorsata* and other species of the same genus. It is regarded that among these related species, type 3, which is represented by *E. taeniura*, is a primitive group, whereas the genus of *Zaocys*, to which *Ptyas* is closely related, is a derived group. *Entechinus* is probably an offshoot derived from a common ancestor at a primitive stage long ago.

The relationship between the structure and function is preliminarily studied, using *Zaocys* and *E. taeniura* as research objects. These animals are all terrestrial and feed mainly on mice, birds, lizards, frogs, and fish. However, various species of *Zaocys* inhabit waterside and favour frogs and fish, while *E. taeniura* lives around human houses and consumes mice as staple food. It is presumed that the volume of the mouth cavity of snakes, when swallowing, depends mainly on their ability to move the maxilla and mandible vertically and horizontally, as well as to move the cervix horizontally. The ability of *E. taeniura* to move its maxilla and mandible vertically is greater than that of *Zaocys*, while *Zaocys* is more capable of moving them horizontally.

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长期大剂量LHRH-A对蟾蜍排精反应的影响

（图版Ⅳ）

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促黄体素释放激素（Luteinizing hormone releasing hormone，LHRH）是下丘脑合成和分泌的一种十肽激素。在正常生理状态下，它作用于垂体促性腺细胞使之合成和分泌LH、FSH，从而维持和调控性腺的正常机能。

但最近十几年来在哺乳动物上证明，大剂量LHRH及其高活性类似物（LHRH-A），无论在雌性动物上还是在雄性动物上，都具有明显的抗生育作用：可使雌性动物终止妊娠（Corbin等，1975；Beattie等，1977；刘以训等，1979；袁其晓等，1978、1985）、使雄性动物精子生成障碍（齐易详等，1986；Yves等，1985）、血浆雄激素水平降低（Sandow，1983；齐易详等，1986）等。但在低等脊椎动物上，LHRH或LHRH-A是否也有抗生育作用尚未见报道。为此，我们在两栖类中华大蟾蜍（*Bufo gargarizans*）上，以排精反应为指标，结合垂体、性腺的细胞学观察，对大剂量LHRH-A的作用进行了探讨，并对其作用机制作了初步分析。

材料和方法

选取体重50-70克的雄性蟾蜍34只，分三组在室温下进行实验。

A组：取22只动物，每只每日早、晚各一次在背部皮下淋巴囊注射100μgLHRH-A（上海生化所生产）。

B组：6只，同上法注射HCG50I.U.。

C组：6只，同上法注射等量（0.25ml）的生理盐水。

注射后2—3小时内取动物尿液镜检，观察有无排精反应。

A组持续注射至不出现排精反应时，再对动物进行如下处理：

1. 取动物6只，每只注射一个正常雄性蟾蜍的垂体匀浆，观察有无排精反应。

2. 6只，每只注射HCG50Iu，观察有无排精反应。

3. 取动物4只，每间隔五天，注射LHRH-A 100μg，观察排精反应能否恢复。

4. 取A组和C组动物各6只，3只的垂体和性腺用Zenker氏液固定，石蜡包埋，垂体用Slidder氏法染色，性腺用Masson氏三色染色（卡林，1982）光镜观察，3只的垂体用2.5%戊二醛和2%锇酸双固定，作电镜观察。

结 果

1. 大剂量LHRH-A诱导的排精反应

A组动物在开始注射LHRH-A的头5天内，每次都有大量活动的精子出现在尿液中。五天后精子量逐渐减少，到14天左右时，全部动物不再出现排精反应。

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在第15天，给6只动物注射正常蟾蜍的垂体匀浆，所有的动物的尿液中又出现活动的精子。

注射HCG的6只蟾蜍尿液中也出现活动的精子。

停止排精后，间隔五天再注射LHRH-A，无排精反应。间隔十天注射时，4只动有3只出现排精反应。

2. HCG诱导的排精反应

B组注射HCG的动物在头五天内也有大量精子排出，之后逐渐减少，但直到第十五天仍有少量活动精子排出。

对照组动物注射生理盐水则无精子排出。

3. 蟾蜍精巢的组织学观察

3.1 对照组（C组）动物的精巢：曲细精管内有大量精子，大部分成簇状嵌在管壁Sertoli氏细胞上，生精作用不活跃（图版Ⅳ，1）。

3.2 LHRH-A组动物的精巢：曲细精管内仍有很多精子，但基本上已从Sertoli氏细胞上游离到管腔中。间质细胞发达（图版Ⅳ，2）。

3.3 HCG组动物的精巢：曲细精管内精子很少，但生精作用活跃。间质细胞也很发达（图版Ⅳ，3）。

4. 垂体的光镜观察

促性腺细胞（嗜碱性细胞）被染成紫红色，嗜酸性细胞呈黄色。长期大剂量注射LHRH-A组动物的嗜碱性细胞内颗粒减少，在油镜下可见细胞内有大量液泡；对照组动物嗜碱性细胞内颗粒众多；HCG组动物嗜碱性细胞情况与对照组相似。

5. 垂体的电镜观察

正常对照组动物的垂体促性腺细胞内含有大量大小不同、电子密度各异的两种颗粒（图版Ⅳ，4），颗粒内的物质都有膜包被；内质网，线粒体不发达。

LHRH-A组动物的促性腺细胞含有大量液泡，表明促性腺素颗粒已经排出，细胞内只残留小部分形态很不规则的分泌物质。粗面内质网、高尔基体和线粒体发达（图版Ⅳ，5）。

讨　论

长期大剂量给予LHRH或LHRH-A在哺乳动物可出现抗生育作用，已为多方面所证实。抗生育作用的机制，目前主要有三种解释：一种认为是垂体促性腺细胞对LHRH失敏。此在完整动物（Sandow，1983）、下丘脑损伤动物（Belchetz等，1978）、卵巢切除动物（Koiter等，1981；Schuiling等，1984）或在体外培养的垂体细胞（Mark等，1981；Mcintosh等，1985）的实验上已得到证明；一种认为是性腺对垂体释放的促性腺素的失敏（Labrie等，1978；Hsueh等，1976；陈钟祯等，1984）。另一种看法认为LHRH或LHRH-A对性腺具有垂体外的直接抑制作用（Hsueh等，1983；Clayton等，1980；Rosario等，1984）。可见，LHRH或LHRH-A的抗生育机制比较复杂。从进化角度来看，LHRH在低等脊椎动物上的促生殖作用与哺乳动物相似。在蟾蜍0.5μg LHRH-A即可使蟾蜍100%的排精，而且LHRH-A这种诱导蟾蜍排精作用的机制是通过脑下垂体释放促性腺素而起作用的（王龙等，1983）。我们的实验结果指出，长期大剂量给予LHRH-A在低等脊椎动物上也具有抗生育作用。抗生育作用的环节在垂体水平而不是在性腺水平。因为在给予LHRH-A不出现排精反应后，给予垂体匀浆或HCG又可引起蟾蜍排精反应，表明长期大剂量给予LHRH-A之所以不再能引起蟾蜍排精反应，不是性腺对促性腺素的失敏，而是垂体没有足够量的促性腺素释放所致。

垂体促性腺素在长期大剂量 LHRH-A 作用下释放减少的原因，从垂体光镜和电镜观察来看，可能是垂体促性腺细胞合成促性腺素的速率跟不上释放的速率，虽然促性腺细胞内粗面内质网、高尔基体和线粒体很发达，但是分泌颗粒基本上已排空。

实验结果指出，长期大剂量 LHRH-A 的抗生育作用是可逆的，在停药十天后，大部分动物又恢复对 LHRH-A 的反应，此与 Yves 等 (1985) 在狗上的实验结果一致。至于动物排精反应恢复后的垂体形态学在不同时间的变化，还有待于进一步研究。

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EFFECTS OF CHRONIC LARGE DOSES OF AN LHRH ANALOGUE ON THE SPERMIATION RESPONSE IN THE TOADS

(Plate Ⅳ)

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Abstract

An analogue of luteinizing hormone releasing hormone (LHRH), D-Ala^{6}-des-Gly^{10}-LHRH-ethylamide, was administered subcutaneously 100μg twice per day in each of 22 toads for a period of 14 consecutive days. The spermiation of the toads was initially accelerated, and then inhibited during the course of treatment. These animals resumed spermiation after an injection of either normal toad pituitary homogenate or human chorionic gonadotropin (HCG) (50IU). A lot of sperms were observed to remain in the seminiferous tubules in the testis slice under microscope. Gonadotropic cells contained large numbers of endoplasmic reticula, mitochondria, and Golgi bodies, as revealed by observation of pituitary gland under electron microscope, while the secretory granules could hardly be observed. The results reveal that after repeated large doses of LHRH analogue the inhibition of spermiation occurs. This may results from the exhaustion of gonadotropin stored in the pituitary gonadotropic cells after the administrations.

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舟山群岛眼镜蛇与滑鼠蛇的繁殖情况

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浙江舟山是多蛇的岛屿，已知的19种陆栖蛇类中，以眼镜蛇科的眼镜蛇(*Naja naja*)及游蛇科的滑鼠蛇(*Ptyas mucosus*)的数量较多。我们在1984年4月、5月和7月及1985年7月和9月，对这两种蛇的繁殖情况进行了研究。

材料与方法

材料来源于浙江舟山岛定海县洋岙及白泉两个活蛇收购站，这些蛇都捕于舟山本岛及其邻近岛屿，先后共得眼镜蛇327条(♀119，♂208)，滑鼠蛇205条(♀100，♂105)。测量和解剖雄眼镜蛇38条，雌性119条；滑鼠蛇雄性18条，雌性100条。测量睾丸及卵的长径和短径；镜检睾丸。雌蛇体内的卵，处于各个发育阶段，我们根据不同时期卵的相对大小，划分为大型卵（卵形大，大小较为一致，当年可能成熟的卵）和小型卵（卵形小，大小很不一致，当年不能成然）两个类型(简称大卵，小卵)。小卵仅测量其较大者。

结果与论讨

1. 雄蛇性腺

雄性眼镜蛇和雄性滑鼠蛇的蛇体全长分别为90.3±14.4(75-130)cm和182.4±19.8(144-225)cm。两种蛇的右睾长度分别为43.7±10.6(26-63)mm和71.3±14.1(45-95)mm，左睾长度分别为34.7±8.4(20-55)mm和60.0±10.8(42-78)mm。右睾显著长于左睾，t值分别为10.7和2.783。睾长与体长的相关系数分别为$r=0.792$和$r=0.585$，均相关。眼镜蛇睾丸长度为体长的4.4%，左右睾丸宽度为9.1±2.4(6-15)cm。滑鼠蛇左右睾丸宽度较为一致，平均为7.7±1.6mm。

眼镜蛇和滑鼠蛇在4月或5月初出洞，5月中、下旬仍处于繁殖阶段，它们睾丸中都有大量成熟精子。眼镜蛇睾丸的相对体积大于滑鼠蛇，睾丸长度分别为体全长的4.4%和3.9%；睾宽分别为睾长的20.8%和10.7%。

2. 雌蛇怀卵情况

2.1 眼镜蛇的怀卵量及卵的发育 1984年5月16-28日解剖的101条雌眼镜蛇，其中体全长为68、81和84cm的3条未怀卵；体全长74-91cm的23条雌蛇均无大卵；5条93cm的雌蛇中，仅2条怀有大卵，占40%，卵数分别为20和23枚；2条体全长95cm者，有一条怀有大卵；95cm以上者，怀大卵数都超

Tab. 1 Egg number of *Naja naja*(16-28, May 1984)

Total length (cm)	No. of samples	No. of snake conceiving large eggs	Size of large eggs (mm)	Av. No. of large eggs	Av. No. of small eggs(6mm)	Av. No. of total eggs
68-80	10	0	—	—	12.7±4.2	12.7±4.2
81-90	15	0	—	—	13.5±8.4	13.5±8.4
91-100	15	10(67.0%)	8.3±0.9*4.6±0.7	20.9±5.2	11.9±3.7	23.7±8.5
101-110	27	25(92.6%)	9.3±1.7*5.0±0.7	21.4±5.5	13.6±5.2	33.1±8.6
111-120	20	19(95.0%)	10.5±2.8*5.4±0.9	22.2±4.7	16.0±8.9	38.0±7.2
121-129	14	14(100.0%)	10.2±1.9*5.3±0.5	23.0±8.8	16.6±6.2	37.2±8.0
	101	68(67.3%)	9.7*5.3	21.9±5.8	14.1±6.2	28.1±11.9

本文于1987年8月21日收到。

2.2 滑鼠蛇的怀卵量及卵的发育 1984年4月28日，共解剖25条，都已怀卵，其中最小的雌蛇体长仅72cm，无大卵。这一时期的卵，虽能区分大、小卵，但还不甚明显(表4)。

Tab.4 Pregnant state of *Ptyas mucosus*, 28 April 1984

Total length (cm)	No. of large eggs	Size of large eggs(mm)	No. of small eggs	Size of small eggs(mm)	Total No. of eggs
72	—	—	40	<4*3	40
144	—	—	51	<5*3	51
153	—	—	15	<6*5	15
167	17	8*6.5	28	<5*3	45
167	—	—	34	<6*5	34
168	—	—	34	<6*4	34
168	—	—	34	<6*4	34
169	19	8*6	22	<4*3	41
171	—	—	53	<6*5	53
171	11	8*5	14	<3*2	25
180	12	9*5	42	<5*4	54
182	—	—	28	<5*4	28
183	22	8*5	12	<4*3	34
184	—	—	37	<5*3	37
189	—	—	15	<6*5	15
193	21	8*5	55	<4*3	76
193	16	9*5	11	<3*2	27
193	—	—	49	<5*4	49
194	17	8*6	35	<4*3	52
195	18	9*6	10	<4*4	28
201	—	—	31	<6*4	31
204	—	—	34	<5*3	34
205	25	8*5	19	<4*3	44
205	8	8*5	20	<4*3	28
207	—	—	49	<5*4	49
178.3±27.2	16.9±5.0	8.2*5.2	30.9±14.1	4.8*3.6	38.2±12.9

1984年5月24-29日，又解剖雌蛇61条，这时所怀大、小卵的分化已趋明显。表5显示，滑鼠蛇体长到180cm以上时，多数个体的性才成熟，怀有大卵的比例超过93%，而体长在171-180cm的雌蛇，当年能产卵的只占52.9%，170cm以下的个体，大都不能于当年产卵。

Tab. 5 Pregnant state of *Ptyas mucosus* during 24-29, May

Total body length(cm)	No. of samp.	No. of snake conceving large eggs	Size of large eggs(mm)	Av. No. of large eggs	Av. No. of small eggs (<6mm)	Av. No. of total eggs
164-170	10	(40%)	10.8±1.3*5.5±0.5	22.8±3.3	25.5±11.5	34.6±13.8
171-180	17	9(52.9%)	10.4±1.5*6.0±0.7	19.7±3.2	36.6±19.0	47.0±13.4
181-190	16	15(93.7%)	11.1±1.5*6.1±0.6	23.9±4.3	27.7±11.5	48.0±9.3
191-200	12	12(100%)	11.4±3.0*5.9±0.5	28.9±4.5	31.6±11.6	60.3±12.7
201-215	6	6(100%)	13.1±3.4*6.9±1.0	25.5±4 8	22.8±9.7	44.8±12.0
	61	46(75.4%)	11.3*6.0	23.6±4.0	30.4±13.4	49.9±10.3

过90%(表1)。表明眼镜蛇体全长达到95cm以上时，可能于当年产卵。

同时从图1可见，眼镜蛇怀卵数与体长显著相关，$r=0.720$。

1984年7月7日，再次解剖11条雌蛇(表2)。结果可归纳为如下三点：(1)大、小卵都有增大，大卵增大特别明显，长径已达40mm左右，大、小卵的区别十分明显；(2)大卵数明显减少（从5月的21.9±5.8枚减至9.0±2.2枚），而小卵数增加，这一现象可能与营养有关。在营养不足的情况下（因捕捉后不再进食），部分大卵继续发育，另一些可能停止发育。据此推测，眼镜蛇的繁殖强度与食物丰富度有关，并会有较大的波动范围，在饥饿条件下，平均产卵9枚(4-12枚)；(3)体长在103-110cm的8条雌蛇，No. 1. 4. 5. 已无大卵，怀大卵蛇的比例仅为62.5%，据表1，在这一体长范围内的雌蛇，怀大卵率为92.6%，表明有些雌蛇已在7月上旬产卵。

Tab. 2 Pregnant state of *Naja naja*, 7 July 1984

Total length (cm)	No. of large eggs	Size of large eggs(mm)	No. of small eggs	Size of small eggs (mm)	No. of total eggs
103	—	—	22	12*5	22
107	4	47*19	45	8*5	50
108	9	47*23	35	6*4	44
108	—	—	36	9*5	36
110	—	—	31	8*5	31
110	9	39*22	29	10*4	38
110	9	37*21	41	7*5	50
110	10	40*17	34	10*6	44
115	12	35*18	30	11*4	42
118	8	46*20	36	9*5	44
122	11	40*22	25	10*5	36
111.0±5.7	9.0±2.2	42.6*20.3	31.8±7.1	8.8*4.6	37.9±12.6

1985年7月23日解剖3条雌蛇，大卵已全部产完。同年9月19-25日，又解剖4条，亦未发现有分化的大卵(表3)，表明眼镜蛇并无分期产卵现象，一年产卵一次。1985年7月22日发现一条雌蛇产卵10枚，卵的量度为51.0±3.2×24.1±0.7毫米。Moriguchi等（1982）记录了从我国大陆及台湾省得到的5条雌眼镜蛇的产卵情况，台湾产的3条，其产卵日期为5月10日，5月20日及6月15日；另2条大陆产眼镜蛇是8月10日。台湾省的气候较舟山温暖得多，产卵期较早是意料之中的事。

Tab. 3 Pregnant state of *Naja naja*, in July and Sept., 1985

Date	Total length (cm)	Size of eggs	No. of eggs	Av. No.of eggs
7.23	127	<7cm	27	
7.23	133	<10cm	34	
7.23	145	<9cm	21	23.8±9.1
9.19	141	<5cm	29	
9.19	145	<7cm	23	
9.25	129	<6cm	32	
9.25	155	<10cm	21	

滑鼠蛇的卵量，与体长不相关，$r=0.281$，与眼镜蛇不同。怀卵量最高的体长范围在191-200cm之间，超过200cm者反而有下降趋势。

1984年7月7日，又获7条雌蛇，其中体长分别为151cm和160cm的2条，未怀大卵。这也补充了表5，体长不足170cm者很少于当年产卵的估计（表6）。

Tab.6 Prengant state of *Ptyas mucosus*, 7 July 1984

Total length(cm)	No. of large eggs	Size of large eggs(mm)	No. of small eggs	Size of small eggs(mm)	Total No. of eggs
151	—	—	27	<4*3	27
160	—	—	41	<12*7	41
167	12	36*20	17	<8*4	29
168	8	46*20	22	<5*3	30
180	9	39*22	29	<10*4	39
182	6	58*18	17	<9*5	23
194	7	44*18	34	<10*5	41
171.7±13.5	8.3±2.3	44.6*19.6	26.7±8.8	8.3*4.4	32.7±7.2

浙江医科大学生物学教研组1975年从浙江南部捕得的雌滑鼠蛇，其产卵期是8月1日，产卵数为15枚，卵的大小为45-50×25-30mm。据卵的量度，舟山滑鼠蛇的产卵期，估计在7月中、下旬。

1985年9月17-21日，所解剖的7条雌滑鼠蛇，大卵早已全部产完（表7）。无论从卵数（表6小卵为26.7±8.8枚，表7为27.6±6.7枚）还是从卵的量度（7月和9月）都较为一致，表明滑鼠蛇也属一次性产卵。

近年来，因蛇皮、蛇胆、蛇毒、蛇肉价值高造成到处过量捕蛇使蛇资源量严重下降的局面。这一现象必须引起重视。许多地方蛇数量的显著下降，可能会引起生态平衡的失调而造成重大损失，如有些地方鼠害的明显加剧，可能就与蛇的减少有关。蛇作为一种资源，可考虑适当的利用，但不分大小，见蛇就捕，将会破坏蛇类资源。通过本文对眼镜蛇和滑鼠蛇繁殖问题的研究，可提供一个利用的限制性措施。建议眼镜蛇限量收购体长在110cm以上的个体；滑鼠蛇限量收购体长在190cm以上的个体；雄性的限量及规格可略放宽。

Tab. 7 Pregnant state of *Ptyas mucosus* during 17-21 Sept. 1985

Date of dissection	Total length(cm)	Maximum size of eggs	Total No. of eggs
9.20	155	7*4	42
9.18	159	8*5	25
9.20	162	5*3	31
9.21	167	8*6	26
9.17	168	9*5	27
9.20	177	7*4	21
9.20	183	10*5	21
	167.3±9.2	7.7*4.6	27.6±6.7

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THE REPRODUCTIONS OF *Naja naja* AND *Ptyas mucosus* ON ZHOUSHAN AND NEARBY ISLANDS

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Abstract

During April and May 1984 and July and September 1985, 327 *Naja naja* (119 females and 208 males) and 205 *Ptyas mucosus* (100 females and 105 males) were captured from the main island of Zhoushan and its nearby islands, Zhejiang province, and were analized through observation and dissection.

The results show that the right testes in the males of both species were longer than the left ones and the difference is significant ($P<0.01$). The average lengths of the right and left testes in *Naja naja* are 43.7 and 34.7mm, respectively ($t=10.7$); and data for the other species are 71.3 and 60.0mm ($t=2.78$).

As for the females of *Naja naja*, those which were as long as or shorter than 91cm could not lay eggs in that year; 50% of those that reached a length of 93-95cm could lay eggs; and 90% of those that measured over 95cm could lay eggs. The average number of eggs in the body, which had a linear correlation with the body length ($r=0.720$, $P<0.01$), was 28.1 ± 11.9; whereas the average clutch number was 9. Egg-laying occured in early and mid July.

Half of the female *Ptyas mucosus* with a length of 171-180cm had an ability of laying eggs; and 90% of those longer than 180cm could lay eggs. The average number of eggs found in the body, not correlated with the body length, was 47.9 ± 10.3 ($r=0.281$, $P>0.05$). Clutch number was 8.3, however. Egg-laying occured in mid and late July.

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简 报

海蛙在广西的首次发现

Rana cancrivora Gravenhorst Discovered in Guangxi

海蛙*Rana cancrivora* Gravenhorst主要分布于东南亚某些热带国家的沿岸，国内报道分布于海南岛。笔者于1987年7月3日和7月10日在广西北海市大冠沙盐田的泥沙滩上采集到15只海蛙标本，现存放在北海市水产馆。

生活时背面为浅黄绿色。背部、头侧及体侧有深色不规则的斑纹。液浸标本灰绿色。

雄性有一对咽侧下外声囊。

海蛙栖息于海湾泥沙滩上。白天隐蔽在泥洞里或水草丛中，傍晚在长有水草的海滩上觅食小形昆虫。雨夜时出洞活动的海蛙较多。雄性海蛙的鸣声较其他种类雄蛙的鸣声小。用电筒光照捕海蛙较之照捕其他蛙类容易。

海蛙在广西除见于北海市大冠沙盐田、横路山蝦场外，防城县及合浦县南康乡营盘海边或半咸水地区亦有分布。

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山东省蛇类一新纪录——团花锦蛇

Elaphe davidi——A Record New to Shandong

据中国《爬行动物系统检索》(1977)记载，山东省蛇类11种。作者自1963年6月起，在济南和泰山进行过爬行动物的采集调查。在整理采集标本中，经鉴定，发现团花锦蛇 *Elaphe davidi* (Sauvage)，系山东省新纪录。

三条标本 1♂，2性别不详。全长平均 298.0+66.3mm。头钝，瞳孔圆形。吻鳞呈马蹄形，头背面约看到1/4部分；鼻间鳞2，宽稍大于长；前额鳞2，近方形；额鳞长明显大于宽，前宽后窄；上唇鳞8，3-2-3式；颊鳞1，近菱形，不入眶；前颞鳞1(或2)；眶前鳞1-2；眶后鳞1或3。背鳞仅最下一行光滑，其余皆起棱，25-23-19行；腹鳞174-180；尾下鳞64对；肛鳞二分。头背部橄榄褐色，眼上棕褐色，枕部多褐色，眼后有一块黑褐色斑纹；体背部灰褐色，躯尾背面正中有一行较粗大的深棕色团斑，约70余枚，斑间淡棕褐色；体侧各有一行较小而不规则的黑褐色粗点斑，大致与中央团斑相间排列，位置在背鳞和腹鳞交界处。腹面近白色，有横波纹状的灰黑色小斑纹。

在调查区该种仅见于泰山桃花峪一带。此处植物茂盛，水源丰富。标本645059号采于小河旁，6372号和645071号均采于石砌干涸水渠内。该蛇性活泼、暴躁，行动迅速。夏季常到水源饮水。在1963年7月8日采到的6372号标本胃内剖出相当数枚鸟卵的壳及卵膜，另有一只半消化的小鸟。本种从东北三省南至河北及山西诸省均有分布，此为山东省首次纪录。

表 团花锦蛇 (单位：mm)

编号	性别	体长	尾长	背鳞	腹鳞	尾下鳞
6372	不详	301.0	65.0	25-23-19	183	64
645059	♂	295.0	72.0	25-23-19	169	64
645071	不详	298.0	62.0	25-23-19	183	64

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天津常见蛇类的复殖吸虫

Digenetic Trematodes from Common Snakes of Tianjin

1986年5月，在天津采集的蛇类中解剖了12条虎斑游蛇和35条白条锦蛇，在两条虎斑游蛇中分别找到吸虫9个和1个，经鉴定认为是两种重盘属吸虫。据记载，重盘科 Diplodiscidae Skrjabin, 1949国内现有三个属，裂盘属 *Schizamphistomum* Looss, 1912寄生于爬行动物，此属目前只有1种，是Fischthal et Kuntz于1975年在台湾的海龟肠中发现的，定名为台湾裂盘吸虫 *Schizamphistomum taiwanensis*；黑龙江属 *Amurotroema* Achmerov, 1959寄生于鱼类，此属现也只有1种，是Achmerov 1959年在鲩肠中找到的，定名鲩黑龙江吸虫 *Amurotrema dombrovskajae*；重盘属 *Diplodiscus* Diesing, 1836寄生于两栖类，此属目前共有16种(表1)。我们这次在蛇体内找到重盘属吸虫，也是天津地区的新记录种。标本测量以毫米为单位，标本保存在南开大学生物系。

1 两盘重盘吸虫 *Diplodiscus amphichrus* Tubangui, 1935 (图1)。

图1 两盘重盘吸虫
Diplodiscus amphichrus Tubangui

宿主 虎斑游蛇 *Natrix tigrina lateralis*
寄生部位 肠
日期 1986年5月
感染 解剖12条蛇，在1条内发现虫9个。

此虫过去所记载的终末宿主有蟾蜍，泽蛙、黑斑蛙、东方铃蟾与中国林蛙，都属两栖类，在蛇体内发现还属首次。过去报道的虫体体长为 3.04–3.76，我们采到的标本较小，体长为 1.131–1.658，口、腹吸盘比为1:2.5。口支囊发达，睾丸与卵巢相接，卵较小。其它特征、器官相对位置均与两盘吸虫模式标本相符。我们所采标本个体较小，其原因可能是在非正常宿主体内，虫体发育受到抑制而影响虫体大小。但是，1973年6月我们在山东烟台捕获的中华大蟾蜍和黑斑蛙内找到的此虫标本，体长为1.951–2.968，在东方铃蟾与中国林蛙肠内找到的标本则更小，体长为0.916–1.198。在鉴定标本时发现，虫体变短粗，肠管曲折，睾丸卵圆形横置并接近两侧肠管，睾丸与卵巢紧密相接等，这些现象有明显的相关性，注意这些因素的变化，有益于我们更准确地鉴定吸虫的种类。

图2 日本重盘吸虫
Diplodiscus japonicus Yamaguti

2日本重盘吸虫 *Diplodiscus japonicus* Yamaguti, 1936 (图2)。

宿主 虎斑游蛇 *Natrix tigrina lateralis*
寄生部位 肠
日期 1986年5月

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表1　　重盘属吸虫的种类、宿主及分布

虫　　名	宿　　主	分　　布
两盘重盘吸虫 *D. amphichrus* Tubangui, 1933	蟾蜍、泽蛙 黑斑蛙、虎纹蛙 东方铃蟾 中国林蛙 虎斑游蛇(宿主新记录)	福建、山东 河北、天津、吉林 菲律宾、印度 缅甸、朝鲜 斯里兰卡
拟两盘重盘吸虫 *D. amphichrus magnus* Srivastava, 1934	爪蟾 *Rana cyanophlyctis* *Rana tigrina* *Hylarana Kassina* *Dicroglossus*	印度、加纳
蟾蜍重盘吸虫 *D. bufonis* Wang, 1977	中华大蟾蜍	上海
日本重盘吸虫 *D. japonicus* (Yamayuti, 1936)	日本大鲵、浮蛙、泽蛙 黑斑蛙、虎纹蛙、粗皮蛙 虎斑游蛇（宿主新记录）	福建，吉林 天津 日本
巨盘重盘吸虫 *D. megalochrus* Johnston, 1912	*Hyla aurea* *Lymnodynastes peronii*	澳大利亚
短肠重盘吸虫 *D. mehrai* Pande, 1937	中华大蟾蜍、黑斑蛙 *Bufo bufo viridis* *Rana cyanophlyctis*	福建、北京 印度 斯里兰卡
微盘重盘吸虫 *D. microchrus* Johnston, 1912	*Hyla ewingii* *Lymnodynastes tasmaniensis*	澳大利亚 加拿大
微小重盘吸虫 *D. minutus* Li et Gu, 1978	黑斑蛙	北京
黑眶蟾重盘吸虫 *D. melanosticti* Yamaguti et Mitunaga 1943	黑眶蟾蜍	台湾
黑斑蛙重盘吸虫 *D. nigromaculati* Wang, 1977	黑斑蛙	福建
帕拉重盘吸虫 *D. pallascatus* Manter et Peitchard, 1964	绿蟾蜍	非洲
囊形重盘吸虫 *D. sacculosus* Yuen, 1962	*Rana erythraea*	马来亚
中华重盘吸虫 *D. sinicus* Li, 1937	沼蛙、泽蛙 黑斑蛙、虎纹蛙	福建、广东
拟棒重盘吸虫 *D. subclavatus* (Goeze, 1782)	中华大蟾蜍 绿蟾蜍、雨蛙 细齿蟾、食用蛙 金线蛙、林蛙 *Bombinator igneus* *Bufo regularis*	上海、吉林 德国、非洲

续表

虫名	宿主	分布
拟棒重盘吸虫 *D. subclavatus* (Goeze, 1782)	*B. vulgaris* *Dendrodryas sp.* *Diplocotyle mutabile* *Emys orbicularis* *Lissotriton* *Molge alpestris* *M. vulgaris* *Natrix natrix* *Pelophylax, Phyrne, Triturus* *Redia gracilis*	上海、吉林 德国、非洲
虎纹蛙重盘吸虫 *D. tigrinus* Wang, 1977	虎纹蛙	福建
具爪重盘吸虫 *D. unguiculatus* (Rud.,1819)	*Triton palusttis*	西德

感染　解剖12条蛇在1条内发现虫1个。

据记载此虫终末宿主有日本大鲵、浮蛙、泽蛙、黑斑蛙，虎纹蛙和粗皮蛙。在蛇体内发现属首次。

标本较小，体长0.245，肠管直且末端与腹吸盘有一定距离，卵巢与睾丸之间有一定距离，卵黄滤泡大。

关于蛇类是如何感染重盘吸虫的，目前还未搞清。两盘重盘吸虫的中间宿主是凸旋螺 *Gyraulus prashadi*，日本重盘吸虫的中间宿主在我国有扁卷螺 *Planorbis compressus* 和隔扁螺 *Segmentina mica*。是蛇在饮水时食入了从螺体中逸出的成熟尾蚴，还是直接吞食了中间宿主或终末宿主而被感染，这个问题有待于进一步研究。

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简报

温度决定部分爬行动物的性别

Temperature-Dependent Sex Determination in Reptiles

性别如何决定？经典地性别遗传理论认为：子代的性别是由亲代的性染色体决定。而性别的表现可分为三个独立而又相关的问题：遗传学上的性别决定；胚胎学上的性别分化；生态学上的性比。有趣的是，大多数动物的性比(♂/♂+♀)为1/2，这种性比的存在与最初的遗传决定有着密切的关系。

但是，爬行动物例如鳄类、龟类雌性的数目超过雄性数倍。

近年来认识到，部分爬行动物的性比由于生态因素（如温度）的影响也发生变化。自1966年以来广泛的细胞遗传学研究以及室内试验和野外观察发现；这些性比发生变化的爬行动物的性别不是由受精时的遗传决定，而是由卵子孵化时的温度决定的(Temperature-dependent Sex determination，简称TSD)。这种客观现象，引起了许多学者的极大关注。本文就国内外近二十年有关温度对部分爬行动物性别决定的研究概况作一介绍。

爬行动物的两种性决定方式

目前已经发现。爬行动物性别决定的方式有两种：一种是异型性染色体决定；另一种是孵化温度决定。

1. 性染色体决定性别　在爬行类中，性染色体的类型比较复杂，甚至有些种类不行有性生殖。在蜥蜴类有6科8属22种动物发现了单性生殖。爬行动物的性染色体有几种不同的复杂情况。在蛇亚目为ZZ-ZW 型，在不同种类中异型化程度不 同。在蜥蜴类具性染色体的种类有XX-XY 和 ZZ-ZW 两种类型。龟鳖类只在一种中发现 XX-XY 型决定性

表 1　爬行类动物的性染色体
（根据Bull，1980年补充）

分类	性染色体种数 已知核型的种数	性染色体类型	异配性别
蛇亚目		ZZ-ZW	♀
鳖科		XX-XY	♂
壁虎科	2/54	ZZ-ZW	♀
微肢蜥科	5/6	$X_1X_1X_2X_2$-X_1X_2Y	♂
鬣蜥科	45/145	XX-XY $X_1X_1X_2X_2$-X_1X_2Y	♂
颈带蜥科	1/46	XX-XY	♂
蜥蜴科	4/33	ZZ-ZW	♀
石龙子科	3/36	XX-XY $X_1X_1X_2X_2$-X_1X_2Y	♂
巨蜥科	4/18	ZZ-ZW	♀

表 2　性别表现与孵化温度无关的种类

分　类	TSD	研究种数	作　者
鳖　科	—	2	Bull等(1979) 侯陵(1986)
蜥蜴科	—	2	Raynaud等(1972) 阚俊樹(1982)
游蛇科	—	1	Osgood(1980)
鬣蜥科	—	1	Muth等(1981)

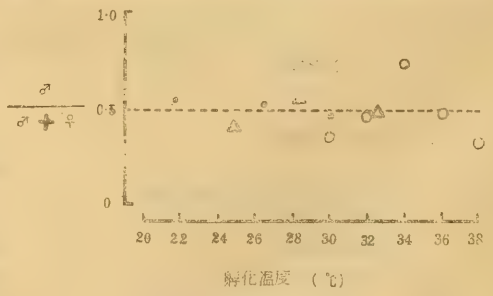

图 1　孵化温度与性比

性别不受温度影响的爬行类，性比约为1/2
○ 鬣蜥科　Muth和Bull(1981)
● 蛇　科　根据Bull(1980)
△ 中华鳖(鳖科)　侯　陵(1986)

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表 3　孵化温度决定性别的爬行动物(根据Bull等补充)

分类		TSD	研究种类	作者
龟鳖目	泽龟科	+	7	Bull等(1979,1981),Pieau(1971－1978,1982)侯陵(1985)
	龟科	+	1	Pieau (1971,1975)
	鳄龟科	+	2	Yetema (1976,1979)
	海龟科	+	3	Yetema等 (1979), Morreale等(1982)
	泥龟科	+	2	Bull (1980)
	两爪鳖龟科	+	1	Pieau (1982)
有鳞目	飞蜥科	+	1	Charnier (1966)
	壁虎科	+	2	Wanger (1980)德永章二(1985)
鳄目	鳄科	+	1	Ferguson 等 (1982)

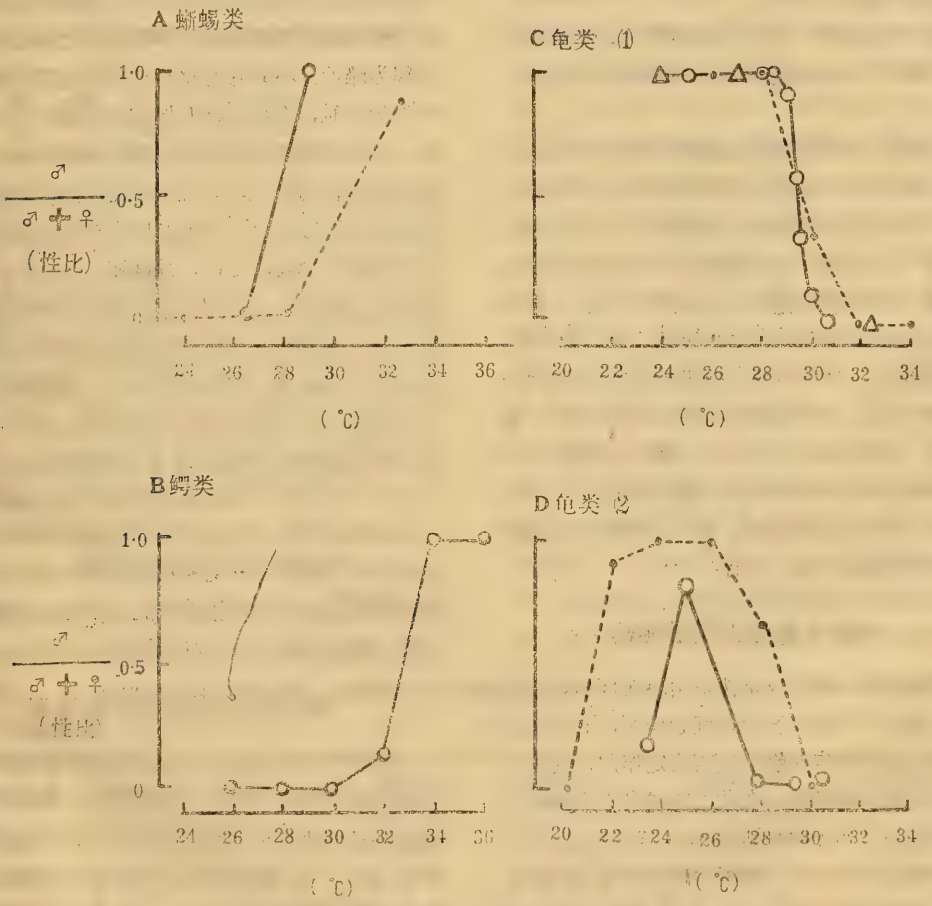


图 2　孵化温度与性比的关系

孵化温度与性比关系的说明:

A. 蜥蜴类:
○ 飞蜥 (飞蜥科) Charnier(1966)
• 壁虎科 根据Bull(1980)

B. 鳄类:
○ 密西西比河鳄(鳄科) Ferguson等(1982)

C. 龟类(1):
○ 图龟 (龟科) Bull等(1982)
● 海龟 (海龟科) Mrosovsky(1980)
△ 乌龟 (泽龟科) 侯陵(1985)

D. 龟类(2):
○ 泥龟科 Vogt等(1982)
● 啮龟 (鳄龟科) Yetema(1978)

别。在这里以蜥蜴类的性染色体较为复杂(表1)。

具有异型性染色体的爬行动物，它们的性别不受孵化温度的影响。现将对不受孵化温度影响性别种类的研究结果归纳在表2和图1中。

2. 温度决定性别(TSD) 目前在爬行类发现具有性染色体的种类较少，而鳄类、大多数龟类、部分蜥蜴类均未发现异型性染色体，它们的性别由孵化温度决定。Charnier(1966)首次发现了温度对爬行动物性别的决定。他把飞蜥(*Agama agame*)的卵放在26-27℃孵化，子代97.8%为雌性，在29℃下子代100%为雄性，而在28—43℃范围下，子代雌雄各自50%。由于他的发现引起了许多生物学者的极大兴趣。近二十年来对温度决定爬行动物性别进行了大量的研究(表3)。

由表3可以看出，相当一类的爬行动物温度决定性别。那么，孵化温度与性比之间的关系怎样？见图2：

综上所述，可以看到孵化温度对爬行动物性别的影响，并不完全相同。有些种类的性别与温度没有关系，有些种类的性别由温度决定，全雌或者全雄仅仅是1—3℃范围(临界温度)。难以理解的是龟类与鳄类、蜥蜴类对温度的反应截然不同。一般规律是龟类在高温下(30-35℃)表现为雌性(雌性决定温度)低温下(20-27℃)表现为雄性(雄性决定温度)(图2，C)，而鳄类和蜥蜴类则与其相反，高温为雄性，低温为雌性(图2，A、B)。而鳄龟科的啮龟(*Chelydra serpentina*)更为特殊，当30℃和20℃时，子代全部为雌性，而在20-30℃之间孵化时，子代为雄性(图2，D)。

产卵环境对性别的影响

1. 温度敏感期 温度决定性别主要在胚胎时期发生作用，但并不对整个发育期间起作用，而只在胚胎发生的一段时期内对性别起着决定作用，这段效应时期便是温度敏感期。在此之前或者以后温度对性别不起作用。Ferguson和Joanen(1982)观察到密西西比河鳄(*Alligator mississippiensis*)的温度敏感期是产卵后的2-3周之间。Bull和Vogt(1981)发现一种水龟(*Chrysemys picta*)的温度敏感期是19期(胚胎发生的分期)，他们做了下述实验(表4)。

这种龟在低温下(25℃)产生雄性，高温下(30.5℃)产生雌性。当分期16时，把低温改变为高温，由于性别尚未决定，故而出现雌性。而分期19时改变温度，由于性别已经决定，故高温下仍为雄性。

表4 龟性决定的温度敏感期

改变温度的方式	改变温度时发生分期	性比 $\left(\frac{♂}{♂+♀}\right)$
25℃→30.5℃	16	0/17
	19	16/16
	18	9/9
30.5℃→25℃	21	5/27
	23	0/19

2. 野外的性别决定 野外实验发现，产卵时的生态环境与性别有着密切的关系。在野外由于种种原因，产卵巢中的温度是变化的。Ferguson和Joanen(1982)室内和野外试验都证明，密西西比河鳄的性别完全由孵化温度决定。卵子在30℃孵化时，后代全部为雌性，在34℃孵化时，后代全部为雄性，在32℃孵化时，有雌有雄，但雌性比雄性多。在野外，位于沼泽阴凉处窝中(平均温度在30℃以下)孵出的后代为雌性，而位于阳光充足产卵窝中(平均温度在34℃以上)孵出的后代99%为雄性。在干燥沼泽地产卵场所不同，温度在31-34℃之间，结果雌性比雄性多。他们统计发现密西西比河鳄在自然界中，平均每6条鳄中只有一条雄鳄。而且雄性只在巢中心上方，温度高处发现。这说明产卵时的生态环境成为性别决定的重要原因，这是由于卵孵化时的温度对胚胎性别发生起着控制。陈壁辉(1983)在对杨子鳄的调查中也得到6条鳄中只有一条雄鳄的结果。作者在乌龟性别的调查也发现雌性数目多于雄性，平均4只乌龟中一只雄龟。雌性的增多可能对动物的繁殖有利，因为一只雄性可以与数只雌性交配，保持种群繁衍。

地理分布和温度决定性别

卵子孵化时的温度决定部分爬行动物的性别，结果该种群的性比取决于环境温度、雌性对筑巢位置的选择和性别决定的胚胎控制这三大要素的相互作用。那么同一种动物在北方和南方的情况下性比怎样？根据龟类温度与性比的关系，如果其他条件相同，那么温度低的北方应该只产生雄性，温度高的南方只产生雌性。但Vogt等(1982)发现在美国北方雄龟比例反而比南方多。那么用什么方法保持着性比的平衡？为此，做了以下设想：(1)临界温度(性比为1/2的温度)发生变化，北方要低；(2)错开筑巢时期，北方要迟；(3)改变筑巢场

所，在北方，在阳光充足处筑巢。Bull等(1982)对上述可能性进行了研究。他们把美国不同地域、同种类的水龟（*Chrysemys picta*）和图龟（*Graptemys pseudogeogra phica*）进行了研究(图3)。

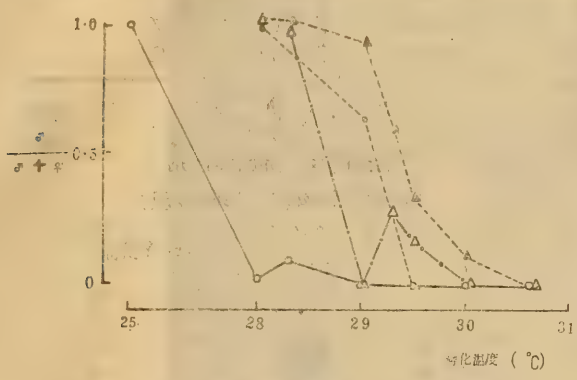


图3　不同地域孵化温度与性比的关系

○——○　水龟（南方田纳西州）
●……●　水龟（北方威斯康星州）
△-·-△　图龟（南方田纳西州）
▲……▲　图龟（北方威斯康星州）

由图3可以看出；(1)与预想相反，在北方临界温度反而要高，对(2)来说，按南方与北方的气温相比，北方比南方的筑巢时间必须迟一个月以上，而实际只迟了二周左右；因此，性比的平衡不是根据(1)(2)，而是根据筑巢场所和位置的选择来控制着种群的性比。如果不是通过筑巢位置的选择等调节性比，则种群内的性比将出现很大的地理差异。这一点如果得到广泛证实，则温度控制性别不存在地域上的差异。

温度决定性别的原因

凡是孵化温度决定性别的种类，大都是目前未发现性染色体的种类。由于它们的后代性别受环境温度影响而变化，故它与性染色体决定性别相比要原始。脊椎动物的远祖是雌雄同体，在进化过程中，两性发生了分离，向雌雄异体发展，以后又出现了性染色体的分化。但进化过程中并不是千篇一律的。部分爬行动物种类或许受到环境的影响，而朝着另一方向进化，出现了孵化温度决定性别的类型。温度决定性别可能是一种长期进化过程中的适应。有关这点有下述两种解释。

1. Charnov和Bull理论　Charnov和Bull(1977)认为受精后的环境决定性别比受精前或受精时的遗传决定性别有利，当卵在某一环境产下后，卵与环境之间就有一种是否适应的问题，而环境的变化很大，因此在各种环境中形成哪种性别的适合度(fitness)是不同的。产卵时的环境如果形成雄性的适合度大于雌性，卵就发育成雄性，反之为雌性。他们认为适合度小的形成雌性，适合度大的成为雄性。Ferguson和Joanen(1982)的工作支持了上述设想。他们把密西西比河鳄卵放在30℃和34℃下孵化，结果在高温下发育成雄性，在低温下发育雌性。除掉体内卵黄重后，两性之间体重差异不同，但体内卵黄重量差异较大。雌性体内卵黄多，雄性体内卵黄少(表5)。在爬行动物体内卵黄为孵化后的营养来源，故卵黄多对未来生长有利。因此他们推论为卵黄多对雌性更快的生长、成熟繁殖，增大自身对环境的适合度是有利的。用Charnov和Bull理论解释在高温下由于体内卵黄减少，形成雌性不利，故而成为雄性。但这种理论目前还不能解释龟类为何在低温下为雄性，高温下为雌性？难道龟类在高温下产生雌性不利？为什么TSD会出现两种截然不同的性比？孵化温度对雌性或雄性的适合度怎样作用？孵化后卵黄重量的差异怎样影响到数年后

表5　孵化温度和子鳄性别、体重和体内卵黄重的关系（根据Ferguson等，1982年）

(1)在室内：

孵化温度	数目（条）	性别	最初卵重(g)	子鳄体重(g)	去卵黄体重(g)	体内卵黄重(g)
30℃	97	♀	65.1±5.7	47.6±3.1	37.8±3.9	8.1±2.2
34℃	94	♂	66.2±6.1	43.7±4.0	38.2±4.6	5.3±1.9
32℃	85	♀	65.8±6.8	46.2±4.5	36.8±4.2	7.7±2.5
	13	♂		45.8±3.9	37.0±4.0	7.6±2.8

(2)在野外干燥沼泽地筑巢时

巢内温度	数目（条）	性别	子鳄体重(g)	去卵黄体重(g)	内卵黄重(g)
31.1±1℃	15	♀	39.1±2.8	28.7±4.4	10.7±1.4
34±0.5℃	3	♂	37.5±0.5	28.8±0.3	8.5±0.5

的性成熟?

2. 亲代控制子代性别　Bull(1981)推测温度决定性别的种类可能是亲代通过产卵场所的选择来控制后代的性别。象这种在不同的产卵场所产生不同性比的事实，在上述的卵类、龟类中已经看到。亲代通过主动地选择产卵场所，间接地控制产卵巢内的温度，从而产生不同性比的后代。当然，仅仅以上述行为就断定亲代能够控制子代的性别，尚难成立。但这的确可以看出龟类和鳄类的亲代有着对后代性别控制的潜力，只是某些控制性别中的极其复杂的因素尚未被人们所揭示。

温度决定性别的机制

现已证明，异型性染色体决定性别与孵化温度决定性别在爬行动物中是不能共存的，即凡是有性染色体的种类，温度对性别没有影响，凡是温度决定性别的动物，就找不到异型性染色体。因此，温度决定性别的发现对经典地遗传决定性别提出了新的课题。温度怎样控制性别，至今了解不多。能村哲郎（1984）设想了一个爬行动物性别决定的模型：

爬行动物温度决定性别的机制模型

弱基因性决定机构（H-Y抗原的存在）

↓

环境（温度、湿度等）的控制

↓

生活环境温度的适应

↓

选择产卵场所，保持性比稳定

（卵生：龟类、鳄类、部分蜥蜴类）

这个模型给我们理解温度决定性别提供了一条线索，但仍难说明温度如何控制性别，有幸的是，近些年为探索脊椎动物性别的奥秘，用H-Y抗原检测没有发现异型性染色体而实际上由基因型决定的物种。H-Y抗原是细胞表面构成的大分子，始终与异配性别相关，即H-Y抗原阳性（+）是异配性别（表6）。这种学说认为H-Y抗原能直接或间接地诱导原始性腺分化为睾丸。缺乏H-Y抗原时，胚后性腺能自然地分化成卵巢。因此，有人试图用H-Y抗原来研究温度决定性别的爬动动物。至今作过H-Y抗原研究的14种龟中，发现13种雌龟为H-Y抗原阳性，仅一种乌龟雌性为阴性，雄性为阳性（表7）。Zaborski等(1982)发现池龟（*Emys orbicularis*）在自然发育情况下，雌性的血细胞和生殖细胞

表6　H-Y抗原与性别的关系

物　种	异配性别	有H-Y抗原的性别
小鼠，人	♂(XY)	♂
鸡，鹌	♀(ZW)	♀
美洲豹蛙	♂(XY)	♂
非洲爪蟾	♀(ZW(	♀

表7　龟类的H-Y抗原和性别

（根据能村哲郎，1984整理）

科	种数	H-Y抗原	
		雄	雌
侧颈龟科	2	−	+
泥龟科	2	−	+
泽龟科	5	−	+
	1	+	−
龟　科	3	−	+
大头龟科	1	−	+

显示H-Y抗原阳性，没有发现性染色体。当卵子在25℃孵化表现为雄性，30℃孵化表现为雌性，在28.5-29℃孵化大部分表现为雌性，部分为雄性或间性。H-Y抗原检测，个体血细胞的H-Y抗原与性别没有对应关系，仅性腺细胞的H-Y抗原与性别一致。即在H-Y抗原存在下胚胎发育成雌性，反之，胚胎发育成雄性。

从龟类也存在着H-Y抗原这一事实来看，即便是没有异型性染色体，但也具有与哺乳类同样的遗传决定性别的背景。从龟类的性别表现型受孵化温度影响这一点来考虑，可以推测孵化温度可能不是性别决定的因素，而只是作用于胚胎发生过程中性腺分化的因素，通过孵化温度影响H-Y基因的活动，从而进一步影响性别的表现型。

孵化温度决定性别揭示了一个极其深奥地性别决定和性别分化的问题，未知因素甚多。尽管目前已有人从H-Y抗原与爬行类动物性别的关系，性激素对爬行类性别的作用，弱性别决定基因对温度决定性别的作用，水的潜在性在温度决定性别中的作用等诸方面来考查孵化温度决定爬行类性别之谜，但至今尚无完整地答案。有待于进一步的研究。

侯　陵

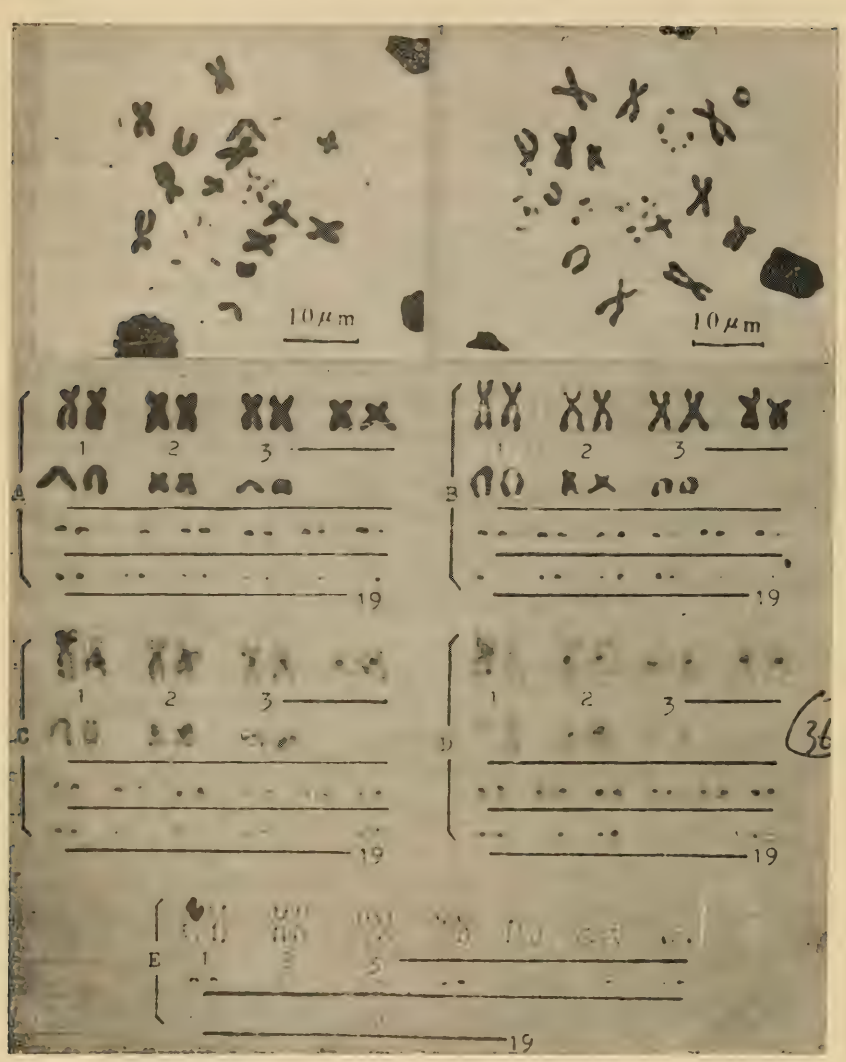
（湖南师范大学生物系）

Hou Ling

(*Department of Biology, Hunan Normal University*)

Fig. 1. A-H: The Karyotypes and C-bands of four *Oreolalax* species
A, B: *O. omeimontis*; C, D: *O. pingii*; E, F: *O. popei*
G, H: *O. rugosa*.

Fig. 2. I-K: The number variation of the chromosomes of *O. rugosa*.
I. 2n=27; J. 2n=28; K. 2n=29.
L: The chromosomes No. 6 from six metaphases of *O. popei*, Showing C-bands heteromorphism.



脆蛇蜥的核型 (A, B)、C-带型 (C, D) 和Ag-NORs (E)
The karyotype (A, B), C-banding pattern (C, D) and Ag-NORs (E) of *Ophisaurus harti* Boulenger

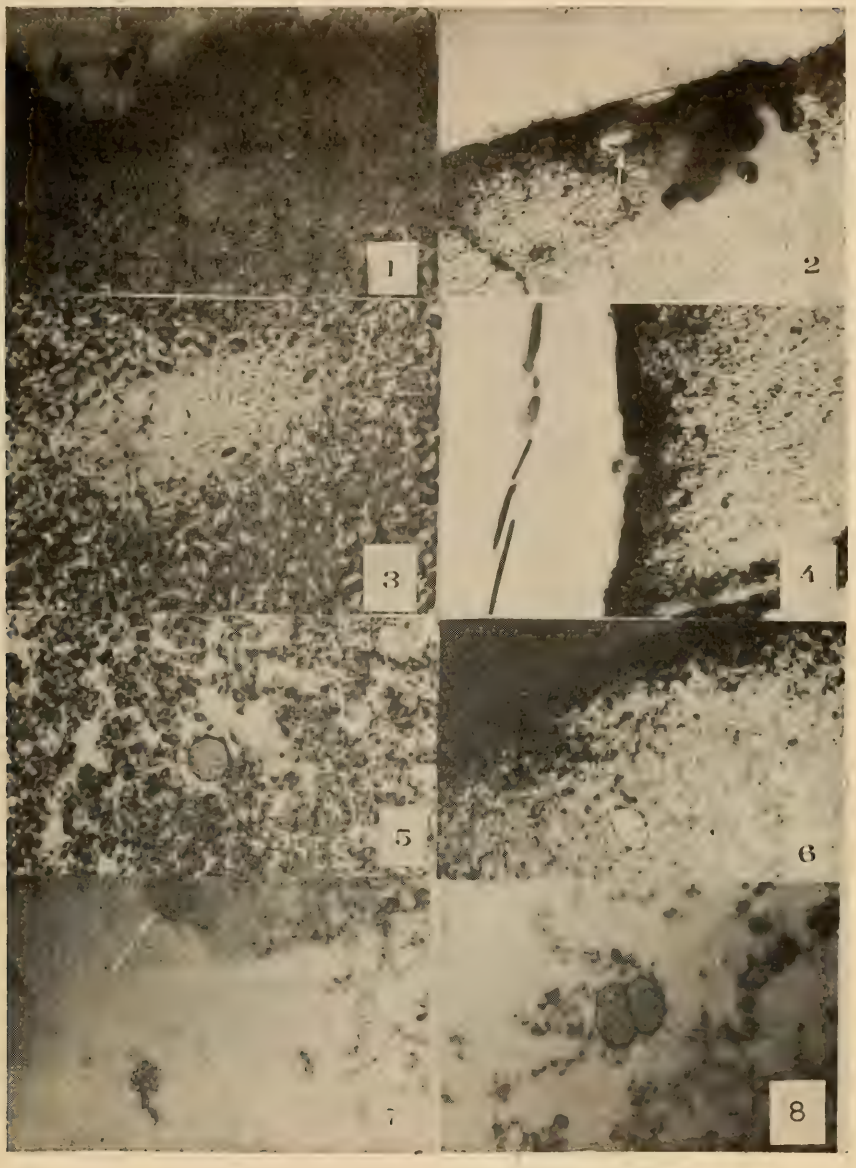


Fig. 1. The unfertilized egg is in meiotic metapase Ⅱ. X1320
Fig. 2. Fifteen minutes after fertilization, the sperm has penetrated into the cortex of the egg. X720
Fig. 3. Twenty-five minutes after fertilization, the sperm head starts to decondense. X1320
Fig. 4. Twenty-five minutes after fertilization, the egg is in the end of meiotic metaphase Ⅱ. X720
Fig. 5. The male pronucleus, fifty-five minutes after fertilization. X720
Fig. 6. The female pronucleus, fifty-five minutes after fertilization, X720
Fig. 7. Two pronuclei in the clear area, seventy-five minutes after fertilization. X720
Fig. 8. Two pronuclei conjugate, ninety-five minutes after fertilization. X720

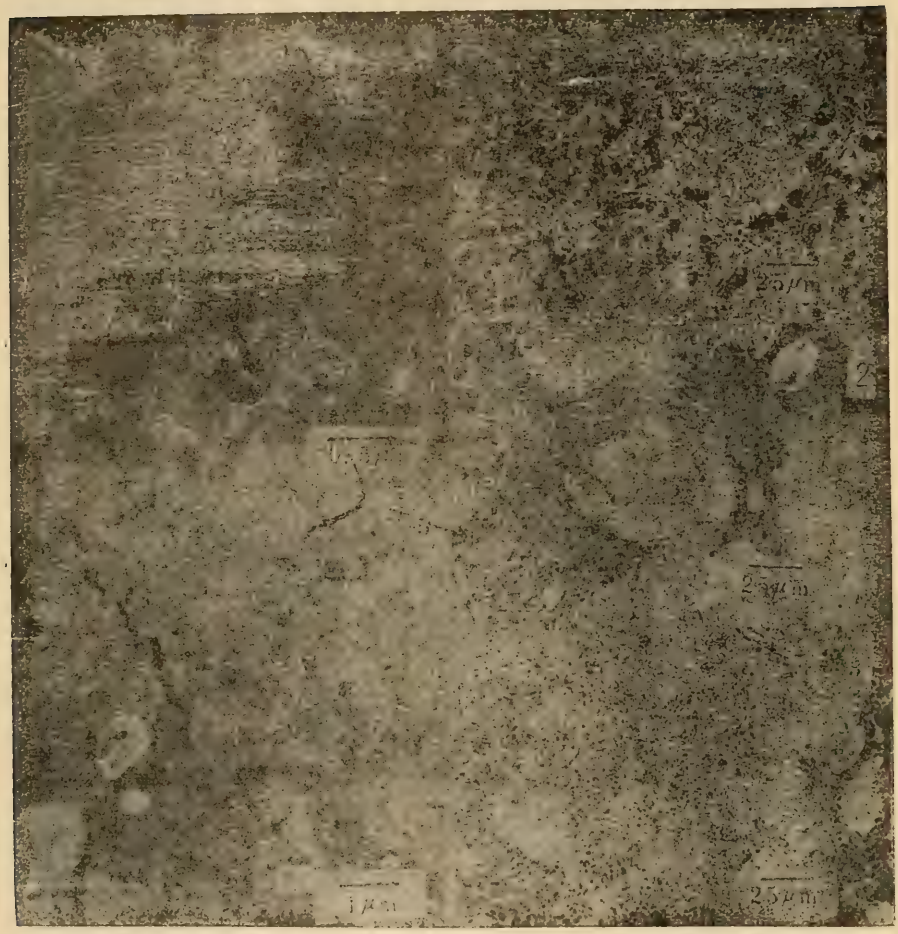


Fig 1. The spermary histology of the normal toads. (X400)

Fig 2. Observation on the spermary of the toads administered twice daily with large doses of LHRH analogue for 14d. (X400). A lot of sperms remained in the seminiferous tubules can be seen when thier spermiation was inhibited.

Fig 3. Observation on the spermary of the contrast toads injected twice daily with 50IU HCG for 15d. (X400). Spermiogenesis is active (⟶) , and spermatic cell is proliferative.

Flg 4. Portion of gonadotropic cell of the normal toads. (X28000). GTH: gonadotropin; Nu: nucleus.

Fig 5. Gonadotropic cell of the toads administered twice daily with large doses of LHRL analogue for 14d. (X11600). Nu: nucleus; G: Golgi body; RE: rough endoplasmic reticulum; V: vesicle; Mt: mitochondria.

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59.123　脆蛇蜥的染色体组型、C-带和Ag-NORs研究[刊，中]/郭超文（安徽师范大学生物系）// 两栖爬行动物学报.-1988，1.-5-9

本文以骨髓和肠组织为材料，研究脆蛇蜥的染色体组型，C-带和Ag-NORs。脆蛇蜥的染色体数2n=38，N.F.=48，其中含7对大型染色体和12对微小染色体，属两型核型(Bimodal Karotypes)。染色体组型可表示为10V+4I+24m。未见有异型性染色体。

经C-带和银染的分析，发现脆蛇蜥的全部染色体均显示着丝点C-带，但C-带带纹有深浅不一现象。脆蛇蜥有两对Ag-NORs，它们均位于微小染色体（No.8,11）上。有Ag-NORs联合现象。

关键词：　脆蛇蜥　染色体组型　C-带　核仁组织

59.123　中国锄足蟾科的细胞分类学研究 Ⅳ.4种齿蟾的核型及其C-带分析 [刊，中]/吴贯夫等（中国科学院成都生物研究所）// 两栖爬行动物学报.-1988，1.-1-4

本文报道齿蟾属中，峨眉齿蟾、秉志齿蟾、宝兴齿蟾、疣悲齿蟾等四种的核型。它们的二倍体数均为2n=26，由五对大的，一对中型和七对小染色体组成，在No.6长臂上均有显著而恒定次缢痕。

关键词：锄足蟾科　细胞分类　核型

59.1153　花背蟾蜍受精卵中原核重建的细胞学研究[刊，中]/武一清等（西北师范学院生物系）// 两栖爬行动物学报.-1988，1.-10-12

为进一步认识原核重建中的核、质关系，选用花背蟾蜍受精卵，对其原核的重建作细胞学研究。

关键词：花背蟾蜍　受精卵　原核　细胞学

58.374　闭壳龟属一新种——金头闭壳龟[刊，中]/罗碧涛等（徐州市三十一中学）// 两栖爬行动物学报.1988，1.-13-15

笔者在1985年10月及1986年10月，获得来自安徽省南陵县的闭壳龟标本3号，经研究，确认为一新种。即金头闭壳龟。

关键词：金头闭壳龟　南陵

59.16　中国福建省和广东省的海龟[刊，中]/Susana Salas Frazier (National Museum of Natural History, Smithsonian Institution, Washington D. C. 20560. USA)// 两栖爬行动物学报.-1987,1.-16-46

1985年6至8月，对福建和广东两省的海域内的海龟类作了考察，发现有以下五种：蠵龟（亚成体）、丽龟（成体与亚成体）、海龟（成体）、玳瑁（亚成体）和棱皮龟（成体与亚成体）。据报导，这两个省的海岸常有海龟类来营巢，但现在仅有海龟一种在该地有明显的营巢活动，而且大多发生在西沙群岛。除海龟在西沙海域被大量捕捞外，几乎其它各种海龟类都只是在捕鱼时被偶然捕获。它们大多在夏、秋两季被捕。

关键词：福建　广东　海龟

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59.17　乌梢蛇属头部的形态学研究Ⅴ．乌梢蛇属、鼠蛇属、锦蛇属和翠青蛇属头部形态的比较研究及其机能和演化初探[刊，中]/张服基(中国科学院成都生物研究所)∥两栖爬行动物学报.-1988,1.-47-55

共解剖比较游蛇亚科10种的头部结构，分隶乌梢蛇属、鼠蛇属、锦蛇属和翠青蛇属。这些属种至少可分为4个不同的类型，即乌梢蛇属和鼠蛇属、翠青蛇属、黑眉锦蛇及三索锦蛇和紫灰锦蛇、王斑锦蛇和红点锦蛇。本文除对头骨、头部肌肉和腺体进行了比较外，同时还对乌梢蛇和黑眉锦蛇的结构和机能的关系作了分析。

关键词：乌梢蛇属　形态学　头部

59.5　长期大剂量LHRH-A对大蟾蜍排精反应的影响[刊，中]/王世立（山东大学生物系）∥两栖爬行动物学报.-1988，1.-56-59

雄蟾蜍每日二次皮下注射大剂量LHRH-A(100μg/只)。开始动物大量排精，五天后排精量逐渐减少，十四天左右排精反应全部消失。此时，给动物注射正常蟾蜍的脑下垂体匀浆或HCG，则动物又可出现排精反应。

精巢组织学检查曲细精管内仍有许多精子存在。长期大剂量射注LHRH-A导致动物排精反应消失的原因是在垂体水平而不在性腺水平。可能是由于垂体释放促性腺素的量大于和快于合成的量，终于导致垂体促性腺素耗竭，不能释放出足以引起动物排精的激素量，从而使排精反应消失。

排精反应消失的动物，在间隔十天后再注射LHRH-A，多数动物又可出现排精反应，表明该反应的消失是可逆的。

关键词：促黄体素释放激素　蟾蜍　排精　脑下垂体　睾丸

59.1914　山东省蛇类--新纪录——团花锦蛇[刊，中]/贾震绪（山东农业大学德州农学专科班）∥两栖爬行动物学报.-1988.1.-66

作者自1963年6月起，在济南和泰山对爬行动物进行调查。在整理采集标本中，经鉴定，发现团花锦蛇，系山东省新记录。

关键词：山东省　团花锦蛇

59.1933　海蛙在广西的首次发现[刊，中]/孙建运（广西北海市水产馆）∥两栖爬行动物学报.-1988，1.-65

笔者在1987年7月3日和7月10日在广西北海市大冠沙盐田的泥沙滩上采集到15只海蛙标本，现存放在北海市水产馆。

关键词：海蛙　广西

58.519　天津常见蛇类的复殖吸虫[刊，中]/李庆奎等（南开大学生物系）∥两栖爬行动物学报.1988,1.-67

重盘属吸虫寄生于两栖类肠道。在爬行类肠中发现重盘属的吸虫两种，不仅是宿主的新记录，也是地区种的新记录。

关键词：复殖吸虫　蛇　天津

58.151 温度决定部分爬行动物的性别[刊，中]/侯陵（湖南师范大学生物系）// 两栖爬行动物学报.-1988，1.-70-74

本文主要对“温度决定部分爬行动物的性别进行了研究。自1966年以来广泛的细胞遗传学研究以及室内试验及野外观察发现，性比发生变化的爬行动物的性别不是由受精时的遗传决定，而是由卵子孵化时的温度决定的。

关键词：爬行动物 温度 性别

59.131 舟山群岛眼镜蛇与滑鼠蛇的繁殖情况[刊，中]/盛和林等（华东师范大学生物系）// 两栖爬行动物学报.-1988，1.-60-64

本文主要对眼镜蛇及滑鼠蛇的繁殖情况进行了研究。共捕得眼镜蛇327条（♀119，♂208），滑鼠蛇205条（♀100，♂105）。测量和解剖雄眼镜蛇38条，雌性119条；滑鼠蛇雄性18条，雌性100。测量睾丸及卵的长径和短径；镜检睾丸。

关键词：眼镜蛇 滑鼠蛇 睾丸 卵

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